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The Canadians and Their Environment Series is a joint project of the
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Institute of Education and intended for use by practicing educators in
enhancing understanding of Canada.

The Canadian Economy — Yesterday, Today and Tomorrow

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Foreword

A.B. Hodgetts in *What Culture? What Heritage?: A Study of Civic Education in Canada*, (Toronto: OISE, 1968), (the Report of the National History Project) presented a "strong indictment" of the way Canadian studies were being taught in the public schools.¹ It stressed the message that "Canadian studies in our elementary and secondary schools have stagnated while many other subjects seem to have surged forward".² The concern generated by this report led directly to the establishment of the Canada Studies Foundation (CSF) incorporated in 1970 as an independent, non-profit organization mandated "to find ways of improving the quality of Canadian studies in the elementary and secondary schools of all provinces".³ From its inception the CSF has insisted that Canadians need a greater degree of understanding of our society, and that knowledge is a necessary prerequisite for understanding. Since 1970, the Foundation has been involved in experimental teacher-centred curriculum development of a pan-Canadian nature.

No other organization has involved so many teachers in cooperative curriculum development endeavours from such a wide-spread geographical area. To be more specific: In its first phase (1970-75), the Foundation completed curriculum projects involving more than 700 people from every level of education and over 8,500 students from all provinces; in its second phase (1975-78), the CSF completed ten additional projects involving 400 educators in all provinces, the Yukon and the Northwest Territories. By February 1981, 51 volumes of learning materials developed as a result of these Foundation-sponsored projects had been commercially published and more than 30 volumes of learning materials were available from non-commercial sources.

As well as being involved in curriculum development activities, the Canada Studies Foundation has developed a bilingual information service used by more than 6,000 persons. It has maintained a fully bicultural operation, providing services to francophone teachers and education officials in ten provinces. It has organized or provided resource personnel for local, provincial and national workshops involving more than 5,500

persons ... Throughout these activities, the Foundation has been consistent in its objective of encouraging mutual understanding and respect among the diverse elements of Canada.⁴

After ten years of experience the Foundation produced a comprehensive rationale for Canada Studies programs. This rationale, authored by Paul Gallagher and A.B. Hodgetts and entitled *Teaching Canada for the '80s* (O.I.S.E. 1978) concluded that while "significant improvements in studies of Canada have taken place over the past ten years"⁵ the development of Canadian studies had reached a plateau. It stresses that:

The need now is for something more than merely continuing expanding what is already being done. The need now is for a cooperative and systematic nation-wide effort to improve the quality of studies of Canada in Canadian schools. The development of ... a common framework of studies consistently "pan"-Canadian in objective and designed in truly "pan"-Canadian fashion, touching all curriculum areas and spanning the full range of school years in a coordinated manner, is now the pressing need.⁶

Elsewhere the authors explain that:

In our work with the CSF, we have found that the normal social process by which our young people develop their values, attitudes, and standards of judgment through strong regional and ethnic forces is not yet balanced in formal education by sufficient opportunities to study, to know about, and to understand Canada as a whole. We believe that *Canada* studies – as distinct from all other more restricted *Canadian* studies – should deal with our society as a totality, in country-wide, interlocking perspectives that can be shared by all Canadians wherever they may live. Otherwise, as the National History Project and many others have emphasized, this area of education will continue to be another divisive force in our society. The Canadian studies movement, in all its variety of techniques and products, should be sustained and nourished. What is needed now, however, is a common framework of ideas that educators in all provinces should use in the development of Canada Studies that will be country-wide in perspectives and objectives. The traditional Canadian practice of different groups and jurisdictions concurrently and independently searching for answers to specific provincial or regional concerns needs to be supplemented by an interprovincial cooperative attack on problems shared by all groups and jurisdictions. The luxury of each going

off in his own direction can no longer be afforded, financially or educationally, in Canada.

This book is exclusively addressed to the question, "What should young Canadians *understand* about their own country?"⁷

Teaching Canada for the '80s is the position statement of the Canada Studies Foundation and all development activities of the Foundation are related to the broad curriculum outline it contains. *Teaching Canada for the '80s* breaks Canada Studies into four separate but interrelated components. These four broad themes are: (1) the Canadian Environment; (2) the Canadian Political System; (3) the Canadian Economic System; and (4) Canadian Public Issues. In order to create material designed to fulfill the objectives of the CSF and to reflect its pan-Canadian thrust a number of regional centres were established, each charged with the responsibility of responding to one of the components. The Atlantic Institute of Education accepted the task of co-ordinating the development of materials that would deal with the theme "the Canadian Environment".

The term "environment" is used in *Teaching Canada for the '80s* "to describe the totality of the basic features of Canada, the interactions between them and their far-reaching effects".⁸ This is a much broader usage than any meaning it might have in biology or ecology and includes the entire Canadian milieu, "the composite of the physical, social and cultural characteristics of Canada, viewed as a single entity".⁹

The "basic features of Canada" which create its environment are those characteristics which collectively make Canada a unique country. It should be recognized that individually these basic features are not unique to Canada but are shared by many political communities. At the same time, it must be realized

... that no other political community has the same composite of basic features and the same relationships among them. And that is what makes Canada a unique political community just as all other political communities have a unique composite of basic features and particular relationships among them.¹⁰

The most important basic features that relate to Canada include:

- (1) Canada is a northern, vast, and regionally divided country.
- (2) Canada has a broad natural resource base composed of both renewable and non-renewable resources.
- (3) Canada is an industrial, technological, and urbanized society.
- (4) Canada is a culturally diverse, multi-ethnic country with two historically predominant linguistic and cultural groups.

sary that they be explained. It would further be useful to students understanding to analyze current issues which illustrate a whole variety of relationships. One such issue might be the building of a pipeline from the far north, as presented in *Teaching Canada for the '80s*.¹⁵ Another might be transcontinental rail transportation or the development of our offshore oil reserves. Such issues should be examined in such a way so that students will not only have the opportunity to understand the debate itself but to develop relationship building skills as well.

Consider the possibilities for learning contained in the examination of the issue of the movement of electrical power from Labrador through the Province of Quebec to national and international markets. This is a controversy that can, and for understanding should, be examined under the heading of the "five basic features". Any discussion of this issue would immediately assert the fact of the northerness of the source of power on the Churchill River. This would draw attention to the fact that much of Canada's natural resource storehouse is considerably north of most of our major population centres. This raises the question of protection of the delicate ecology of the North, the safeguarding of the position of northern people and the demands of the rest of the country. The energy supply of Labrador is electrical power and while the river runs it will be produced. This, however, centres attention on the issue of the use of renewable and non-renewable resources, and also on the fact that Canadians, again partly due to our size and our northern location, are the largest users of energy in the world.

The difficulty of transporting the electrical power of the Churchill is not only due to climate, distance, topography, and ecological considerations, but also provides an example of regional and provincial division within Canada. The Province of Newfoundland and Labrador has long demanded that they be allowed to move the power across the Province of Quebec without dealing with the Hydro Quebec middleman. This has not yet been possible. Newfoundland insists that if interprovincial pipelines can be constructed so can an interprovincial hydro-line. The Government of Canada has been caught in the middle. In the balance lies national needs, provincial rights, federal-provincial relations, financial considerations and perhaps the historic claim of Labrador by Quebec. This study would also consider the need for energy far from its source revealing Canada as a highly developed, technological, industrial and urbanized state. It would also reveal that much of the Labrador power is destined to markets in the United States. This fact opens the subject to the examination of our peculiar relationship to our only continental neighbour. This examination would expose the fragility of our cultural and national existence and the inherent dangers of "sleeping with an elephant".

Any classroom teacher would be able to develop these, and other, relationships in any number of similar topics. What is stressed here is that such relationships must be drawn and that students must be given the opportunity to acquire the prerequisite background information

the material and also contain suggestions on other sources of information. Care has been taken that each is as up to date as possible.

A careful reading of the material will demonstrate its usefulness to teachers. It will also be equally obvious that there are a number of ways that it can be used. Some readers might be interested in only one or two of the aspects of these studies. These will find that each is a separate unit (insofar as that is possible) and can be read (although perhaps incompletely understood) without dealing with the other areas. These readers will find that the "Teachers' Notes" tend to deal with each topic individually. It must be stressed, however, that, even if each unit is taught separately, or if only one of the five is used at all, one should

... emphasize the interrelationships of these features. Out of such a study should come a synthesis: a view of the nature of Canadian society seen as a whole, the consequence of a composite of the basic features of the Canadian environment and their interaction. The broad objective throughout the study should be to help students develop an overview of the character of Canadian society, the forces that have shaped it, and the institutions that have sustained it.¹⁴

Readers will discern that there are two important elements within the discussion of the Canadian environment. The first includes the basic features and a consideration of how these are interrelated, while the second emphasizes the consequences of the above on Canadian society. The consideration of interaction of geography, history, economics, resources, and people should reveal much about what makes Canada unique and distinctive.

Relationships among the basic features can be developed as each individual unit is covered. That Canada is both physically enormous and diversified is obvious after studying Doreen Tomkins' section. A similar reading of Anthony Burton's study of the people of Canada reveals that the people who occupy the land are equally diverse in their origins and cultural backgrounds. The reaction of these peoples to the land and their use of the natural resources, as described by Maurice Mandale, has a direct relationship to the economic development of Canada as discussed by Lesser and Roald. But, as is emphasized in the economic considerations, few countries are allowed to develop uninfluenced by their neighbours. Therefore, Howell's work examining Canada's place in the world helps to further explain the fact of Canada. While history may not have a great effect on the physical environment it has had enormous influence on what physical environment is to be included in any political community and by whom and how the physical environment is to be used. There can be no question of the impact all of these features have had on the cultural environment. While it is unnecessary to further elaborate these initial relationships it is neces-

- (5) Canada is exposed to a multitude of external economic, political, and cultural influences.¹¹

While the authors point out that these characteristics are not meant to be subject to a deterministic interpretation they do suggest that these characteristics provide "strong constraints within which policy formation, leadership, and authority must be exercised and public opinion formed in Canada".¹²

The set of materials published under the series title *Aspects of the Canadian Environment* deals directly with the five basic features which characterize the Canadian environment. Each basic feature has been developed to provide teachers and interested readers with sufficient background information to create a working base of knowledge upon which to build their understanding of the country. It should lead to an understanding

... that the basic features are the major sources of diversity in Canada; that they are strong factors in the formation of public opinion and the differences in viewpoint on public issues in various parts of the country; that they generate most of the problems of continuing concern to Canadians and cause social tension; and that they substantially influence the structure and functioning of Canada's political and economic systems. All other Canada Studies should be approached with the background knowledge provided by a careful analysis of the basic features of this country.¹³

There are thus five sections to this series, each of which includes a major paper as well as a set of "notes for teachers" dealing with the pedagogical aspects of the material. The five sections are:

- (1) "Canada: A Land of Physical Diversity" by Doreen M. Tomkins, and (1a) Teachers' Notes by the author;
- (2) "Canada's Natural Resources and their Use" by Maurice Mandale, and (2a) Teachers' Notes by Marcia Armstrong;
- (3) "Canadians and their Economy: Today, Yesterday, and Tomorrow" by Barry Lesser and Bruce Roald, and (3a) Teachers' Notes by the authors;
- (4) "Canada's Peoples" by Anthony Burton, and (4a) Teachers' Notes by Gordon Watson; and
- (5) "Canada and the Wider World" by Colin Howell and (5a) Teachers' Notes by Glenda Redden.

These follow closely the five basic features given above and provide pertinent background information and a bibliography for further reading. The notes for teachers offer ideas for classroom presentation of

and the necessary skills to assist their own understanding of this country as well as introduce students to some of the complexities of making major decisions in Canada.

This example and those contained in *Teaching Canada for the '80s* demonstrates the process by which a more complete understanding of an issue can be developed. Again, the various parts of this series will greatly assist in bringing about this understanding as they supply the prerequisite background information.

If studying the basic features and the interrelationship among them helps answer the question "Why?" then examination of the consequences these hold for Canadian society should address the question "So What?". Just as the examination of causes allowed students the opportunities to analyze an issue — to break it down into its component parts and study each separately — the consideration of consequences will give them the opportunity to synthesize the findings — to rebuild the evidence in response to a particular problem. This skill may lead them to discover that while all Canadians have many of the same basic desires they also have many, and sometimes conflicting, loyalties. Regionalism, spawned by geography and reinforced by history, economic disparity due to an uneven distribution of natural resources and a variety of economic opportunities, and a richly diverse population often associated with one region, or one part of a region, have all helped to create loyalties that have threatened the unity of Canada itself. The challenge for Canada is to balance diversity and unity. Hopefully, some students will

... begin to recognize that, if Canada is to respond to the legitimate and diverse aspirations of all its members, some level of consensus among Canadians is necessary to balance the normal frictions among groups in Canada.¹⁶

There is no one single "correct" story of Canada, just as there is no one "correct" Canadian. The interpretation of the development of one region cannot represent the story of the development of the nation. Each region and sub-region and each of Canada's peoples has their own story. Unity can, however, be found in the basic features, their interrelationships and their consequences. Their study will help inform students of what Canada is and why it developed as it did. This background will provide students with the setting for more sophisticated studies of Canada and perhaps help respond to the charge that Canadian schools are not sufficiently Canadian.

As co-ordinating editor of this series of new works expressly developed for it, I would like to express my gratitude to the authors who worked so diligently to marry their academic interests and expertise with the curriculum demands of *Teaching Canada for the '80s* and the perceived needs of junior-high school teachers. Thanks too are extended to the many reviewers, too often forgotten, who examined these works

and subjected them to a most rigorous scrutiny and in no small way will be responsible for any success they may enjoy. The encouragement, support, and leadership the project received from the Atlantic Institute of Education and the Canada Studies Foundation in the persons of Dr. William Hamilton, Dr. Andrew Hughes and Dr. Robert Anderson has been much appreciated. Special thanks are also extended to Beverly Quillan, Joanne Eisener and John Knight of the Atlantic Institute of Education.

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FOOTNOTES

1. A.B. Hodgetts, *What Culture? What Heritage?: A Study of Civic Education in Canada*. (Toronto, OISE, 1968), p.5.
2. *Ibid.*, p. 7.
3. The Canada Studies Foundation, *The Work of the Canada Studies Foundation*, (Unpublished Document, 1981), p.1.
4. *Ibid.*, pp. 1-2.
5. A.B. Hodgetts and Paul Gallagher, *Teaching Canada for the '80s*, (Toronto: OISE, 1978), p. v.
6. *Ibid.*, p. vi.
7. *Ibid.*, p. 2.
8. *Ibid.*, p. 13.
9. *Ibid.*, p. 37.
10. *Ibid.*, p. 10.
11. *Ibid.*, p. 12.
12. *Ibid.*, p. 13.
13. *Ibid.*, p. 12.
14. *Ibid.*, p. 37.
15. *Ibid.*, p. 47-48.
16. *Ibid.*, p. 50.

The Land

Canada is sometimes referred to as "a sort of horizontal Chile." Certainly about ninety per cent of the population is concentrated along the southern border in a strip some 6,000 kilometres long not more than 500 kilometres wide and known variously as southern Canada, base Canada, active Canada or even useful Canada. The enormous costs and difficulties of maintaining contact with fellow countrymen up to six time zones distant are practical reminders of the tremendous latitudinal extent of the country. The development of Canada is usually perceived as an unrolling of the map westward and three centuries were required for European settlement to push through the varied terrain from the Atlantic coast to the far West. Even using modern jet aircraft it requires eight hours or more to complete the journey from coast to coast.

It is less easy for Canadians to comprehend the equally enormous longitudinal extent of their country. To a considerable degree, the North (most of the country) is still unknown. Three hundred years of effort have failed to push the agricultural frontier more than a fraction of the distance between the southern and northern boundaries. Few Canadians have ventured "north of sixty" and even fewer live there permanently. Though fundamental, only the most skeletal communications exist between the southern strip of Canada and the great northern hinterland.

Although the most southerly tip of Canada, Middle Island in Lake Erie, is closer to the equator than it is to the pole, Canada is above all a northern country. Most of it lies north of the 49th parallel and, because of the advection of polar masses and the movements of sea ice, it experiences conditions which are even more severe than is customary for these latitudes. Thus, nearly half the country is underlain by continuous or discontinuous *permafrost*, about one third is north of the tree-line and nowhere does the *growing season* exceed four months. There are almost as many ways of delineating the North as there are scholars. They would define North as (1) the tundra-taiga boundary, (2) the boundary of continuous permafrost, (3) the 10°C July isotherm, (4) the line beyond which it is possible to grow cereals, or (5) those parts of the country with more than 500 VAPO¹ to name but a few. Using L.E. Hamelin's index of Nordicity (see figure 1) which is based on ten criteria reflecting both human and physical factors, Canada has far higher

¹ Polar Values. See L.E. Hamelin, *Canada: A Geographical Perspective*. John Wiley & Sons, Toronto, 1969, pp. 30-36.

Figure 1 NORDICITY INDEX: CRITERIA, CLASSES, SCORE

<i>Criteria</i>	<i>Classes</i>	<i>Score</i>
(1) Latitude	90 degrees	100
	80 degrees	77
	70 degrees	55
	60 degrees	33
	50 degrees	11
	45 degrees	0
(2) Summer heat	0 days above 42°F (5.6°C)	100
	40 days above 42°F (5.6°C)	80
	60 days above 42°F (5.6°C)	70
	80 days above 42°F (5.6°C)	60
	100 days above 42°F (5.6°C)	45
	120 days above 42°F (5.6°C)	30
	135 days above 42°F (5.6°C)	20
	More than 150 days above 42°F (5.6°C)	0
(3) Annual cold	More than 12,000 day-degrees F below 32°F (0°C)	100
	10,000 day-degrees F below 32°F (0°C)	85
	8,500 day-degrees F below 32°F (0°C)	75
	7,000 day-degrees F below 32°F (0°C)	65
	5,250 day-degrees F below 32°F (0°C)	45
	3,500 day-degrees F below 32°F (0°C)	30
	2,250 day-degrees F below 32°F (0°C)	15
	Less than 1,000 day-degrees F below 32°F (0°C)	0
(4) Types of ice:	Permafrost, continuous and 1,500 ft thick (457 m)	100
	Permafrost, discontinuous	60
	(i) Permafrost	
	Frozen ground, for 9 months	50
	Frozen ground, for 4 months	20
	Frozen ground, for less than 1 month	0
	Permanent pack ice in the Arctic Ocean	100
	Pack ice in the peri-Arctic (Baffin)	90
	or	
	(ii) Floating Ice	
	Pack ice for 6 months	40
	Pack ice for 4 months	20
	Pack ice for less than 1 month	0

northern values than its neighbours. Thus Edmonton, Alberta at 53° has the same nordicity as Narvik, Norway at 68° N, Churchill, Manitoba at 58° N is comparable to Norilsk, U.S.S.R. at 69° N and Resolute, N.W.T. at 74° N is as northern as the Franz Joseph Islands, U.S.S.R. at 81° N. This means that Canada has a very high proportion of its land in the Extreme North (see figure 2) and the Far North. By contrast, only about one third of either Alaska or the U.S.S.R. belongs in these categories.

In the past, Canada was at the centre of the largest and most powerful ice sheets ever to cover the earth. On at least four occasions the country virtually disappeared from view beneath the ice. The plateau icecaps of Baffin Island may be relics of the last ice sheet which did not disappear until about 6,000 years ago — just yesterday, geologically speaking. Canada's cold winters are usually reminders of these glacial conditions. Most of the country remains frozen for weeks or months and the lands-

Criteria	Classes	Score
(iii) Glaciers	Ice cap - 5,000 ft thick (1,524 m) and more	100
	Ice sheet - above 1,000 ft (304 m)	60
	Névé	20
	Snow cover for less than 11 months	0
(5) Total precipitation	Less than 4 in (100 mm)	100
	8 in (200 mm)	80
	12 in (300 mm)	60
	16 in (400 mm)	30
	More than 20 in (500 mm)	0
(6) Vegetation	Stony desert	100
	Thin tundra	80
	Thick, shrub tundra	60
	Open forest (subarctic, parkland)	40
	Continuous forest (coniferous)	0
(7) Accessibility other than by air (heavy transport)	No service	100
	Seasonal service:	
	(i) once a year	80
	(ii) for 2 months	60
	(iii) for 6 months, or 2 seasons	40
	Service throughout the year:	
(8) Air service	(i) 1 form only	20
	(ii) more than 1 form	0
	Nearest airfield - approx. 1,000 mi (1,600 km)	100
	Nearest airfield - approx. 300 mi (480 km)	80
	Nearest airfield - approx. 30 mi (48 km)	60
	Regular service, twice a month	40
(9) Population:	Regular service, twice a week	15
	More than 1 service a day	0
	None	100
	(i) Number of inhabitants in a settlement	
	From 20 to 30	90
	Approx. 500	75
(10) Degree of economic activity	Approx. 1,000	60
	Approx. 3,000	20
	More than 5,000	0
	Uninhabited	100
	(ii) Population density of the region (100,000 sq mi or 256,000 km ²)	
	0.01 persons per sq mi (0.004 per km ²)	90
(10) Degree of economic activity	1 person per sq mi (0.4 per km ²)	70
	2.5 persons per sq mi (1 per km ²)	50
	5 persons per sq mi (2 per km ²)	25
	10 persons per sq mi (4 per km ²)	0
	No production and none foreseeable	100
	Prospecting, but not yet exploited	80
(10) Degree of economic activity	Gathering, or extractive industries or crafts	50
	Large ore deposits, entrepot, or terminus	30
	Large secondary industries	15
	Interregional centre for multiple services	0

Source: L.E. Hamelin, *Canada: A Geographic Perspective*.

cape is buried beneath a mantle of undisturbed snow. At present there is sufficient summer warmth to melt almost all of it, but only very slight climatic fluctuations would be required for the climate to revert to glacial with a subsequent rebuilding of the great continental ice sheets. Some scientists view the unusually cold and snowy winters of the 1970s as evidence of this risk.

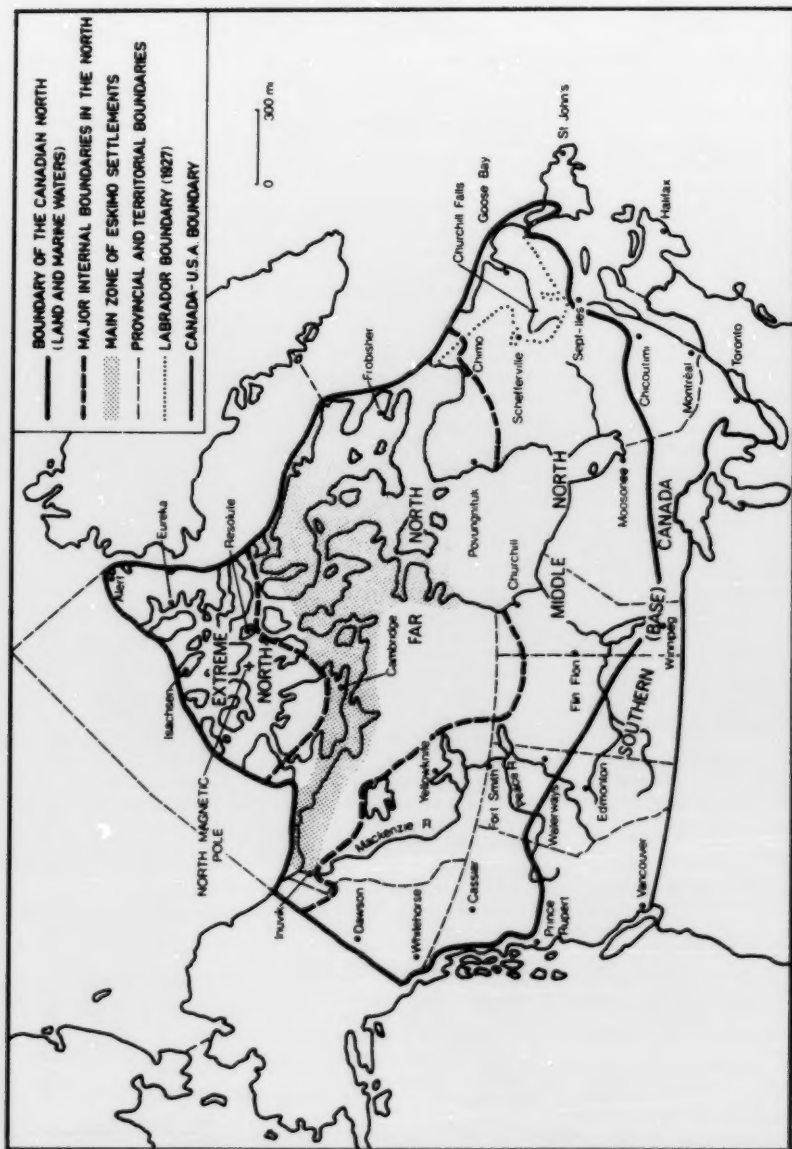


Figure 2 NORTHERN ZONES OF CANADA

Source: L.E. Hamelin, *Canada: A Geographical Perspective*

Along with cold, the dominant characteristic of northern climates is extreme seasonal contrast. Although winters are both long and severe, summer temperatures can rise to very high levels. Aklavik, N.W.T., north of the Arctic Circle has recorded a temperature of 40°C . High annual ranges are the rule in Canada. Regina, Saskatchewan, for

example, has recorded extreme temperatures of 43°C and -49°C , and the average annual range at this station is 36°C . Across the country Kamloops, Toronto, Québec, and Halifax, have average annual temperature ranges of 27°C , 26°C , 30°C , and 22°C respectively. Canada really experiences two seasons separated by relatively short periods of transition and seasonal rhythm is one of the most characteristic features of Canadian life. Only the strip of land along the Pacific coast can rightly be called temperate.

Historian W.L. Morton has observed that for Canadians, doing something about the weather is both an annual ritual and a serious business. Certainly the cost of adapting individuals, structures and transportation to winter conditions is a significant factor in the Canadian economy. In southern Québec for example, snow removal costs approximately \$30 million for the Department of Highways alone. Snow is also an asset, however. Although it imposes restrictions on agriculture and mining, snow is of great value to forest, tourist and manufacturing industries and it is in winter, when roads can be established on packed snow and ice, that transportation in the North is at its cheapest and best.

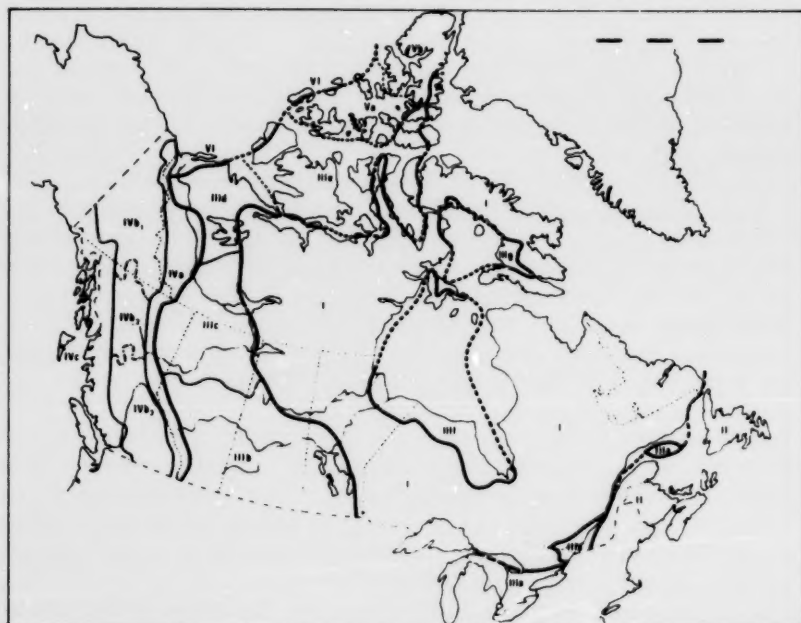
Canadians have learned to live with winter but it is in the transition seasons of spring and fall that some of the greatest problems occur. The freeze-thaw situation shatters rocks and roads, arrests growth and affects navigable waterways. A peculiarly northern phenomenon is the spring freshet — the spectacular floods of enormous erosive power which burst forth each year with the onset of warm weather. Spring breakup is an annual reminder that the familiar landforms of Canada are largely those of recently glaciated areas being worked over by very youthful streams. Erosion is intensified by the torrential rain and hail associated with the thunderstorms which are characteristic of the northern summer. Such violent, essentially northern, erosive processes have been very influential in the evolution of the Canadian landscape.

Canada was discovered and developed as a consequence of the search for the Northwest Passage by explorers and colonists from the northern parts of Europe. The first landbased attraction was high quality fur. The harsh conditions of the North forced the Europeans to live among the Indians and the intermingling resulted in the creation of a significant mixed-blood population, one of the most prominent sociological distinctions between Canada and the United States. While the quality of fur is a direct consequence of the northern climate, it is obvious that the north severely limits the extent and character of Canadian agriculture. It can also be argued that their northerly environment limits the integration and longevity of Canadian cities. A significant proportion exist on a single economic base and the future of such cities is at best uncertain. Fur forts, lumber towns and mining communities such as Tadoussac, P.Q., Renfrew, Ontario; Dawson, Y.T. and, more recently Elliott Lake, Ontario and Uranium City, Sask., have flourished briefly and then declined. The origins of Halifax, Québec, Montréal, and Toronto lie in

trade, not in the riches of the neighbourhood. Even the more favoured cities of southern Canada witness many people vacationing for as long as possible as soon as winter weather arrives. W.L. Morton's thesis that "This country insofar as it is distinctive is a response to the character and influence of the North,"² is being increasingly explored by scholars. The North is common to all provinces except the Maritimes and northness has been identified as a great unifying factor in Canada.

Nevertheless, almost 10 million square kilometres is an enormous area for one political unit and it is scarcely surprising that the different parts of Canada have developed in different ways. At least six quite different units are clearly identifiable.

Figure 3 THE PRINCIPAL PHYSIOGRAPHIC REGIONS OF CANADA



- | | | |
|------------------------------------|------------------------------------|------------------------------|
| A I The Canadian Shield | d) Mackenzie | c) Coast ranges |
| B The Border Regions | e) Arctic | V Innuitian Region |
| II The Appalachian-Acadian Uplands | f) Hudson Bay | a) Southern plains and hills |
| III The Interior Plains | g) Foxe Basin | b) Northern mountains |
| a) St. Lawrence | IV The Western Cordillera | VI Arctic Coastal Plain |
| b) Prairie | a) Eastern mountains | |
| c) Peace-Slave Lowland | b) Interior plateaus and mountains | |

Source: J.B. Bird, *The Natural Landscapes of Canada*.

² W.L. Morton, "The 'North' in Canadian Historiography." *Transactions of the Royal Society of Canada, Series IV Volume VIII*, 1970.

The Canadian Shield

The dominant unit (see figure 3) is the Canadian, Laurentian or *Precambrian* Shield. This vast sweep of rock, lake, muskeg and forest stretches over nearly 50 per cent of the mainland area and personifies the essentially Canadian characteristics of vastness and northness. It is the only physiographic region of North America that is almost entirely Canadian and as such it remained largely unknown until the second half of the twentieth century. Scientist-explorers had been active in the United States for a hundred years and by 1916 had produced Fenneman's map which became the basis of most physiographic subdivisions. Canada was viewed by one and all as an extension of the United States.

The Shield was largely ignored in Fenneman's map. However, it formed the nucleus around which the continent developed and, in buried or exposed form, accounts for more than half the total land mass. It was not until 1964 that H.S. Bostock argued that the initial division of North America should be into two regions, the Canadian Shield and the remainder of the continent (or Borderlands). The significance of the Shield to Canadian identity had already been recognized by historians. H.A. Innis, writing in 1930, observed that "Canada emerged as a political entity with boundaries largely determined by the fur trade" and that "The area which was crucial to the development of the fur trade was the Precambrian Shield."³ While one scholar has attacked the first statement as an extreme example of economic and inaccurate determinism, few dispute the truth of the second, or question that the Shield-based fur trade was extremely significant in the development of North America.⁴

D.G. Creighton too considered that "The Canadian Shield and the river system which seamed and encircled it, were overwhelmingly the most important features of the area. They were the bone and bloodtide of the northern economy . . . It was on these ancient rocks that the central emphasis of the Canadian system was placed at first, and the initial importance of the Shield is of deep significance in the economy of the north."⁵ He regarded the unifying features of the great east-west waterways as far more significant than the general north-south grain of the country.

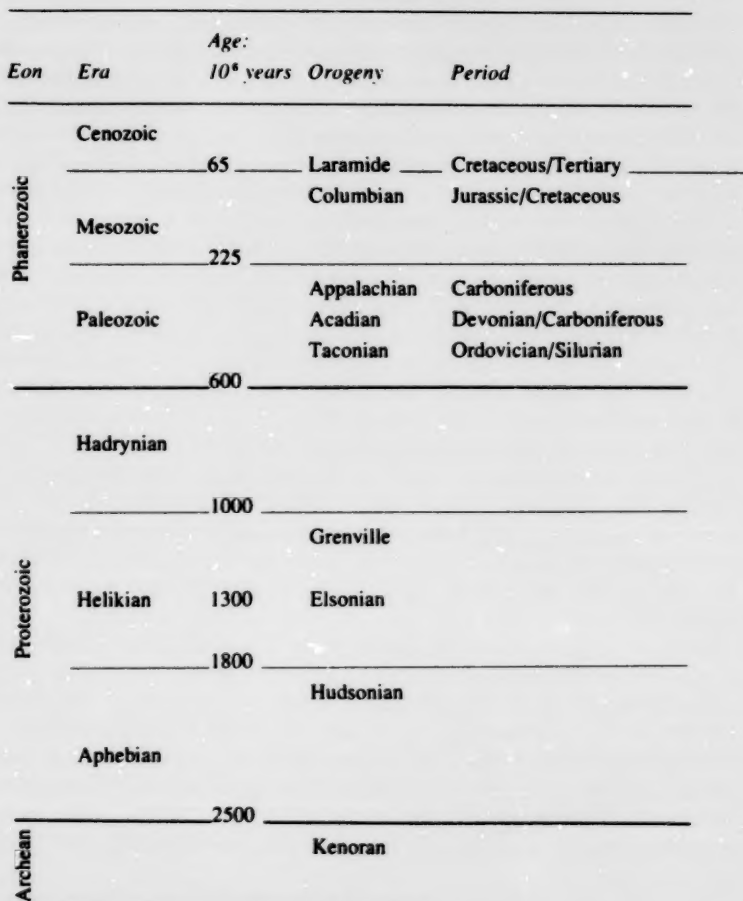
It is not surprising, therefore, that the Shield contributes greatly to Canada's self image. It is the natural home of our national symbols, the maple and the beaver. It is the habitat of our folk heroes, the voyageurs, lumberjacks and prospectors. It is the locale for much Canadian literature and has been immortalized on canvas by the Group of Seven. It is valued as the source of several of our greatest natural resources and as a place for relaxation and renewal. Its great extent and its proximity to

³ H.A. Innis, *The Fur Trade in Canada*, Yale University Press, revised edition, 1962, p. 388.

⁴ See W.H. Eccles, A Belated Review of Harold Adams Innis' "The Fur Trade in Canada". *Canadian Historical Review*, Vol. LX, No. 4, December, 1979.

⁵ D.G. Creighton, *The Empire of the St. Lawrence*, MacMillan, Toronto, 1956, P. 5.

Figure 4
THE GEOLOGICAL TIME SCALE IN
CANADA: THE MAIN MOUNTAIN-
BUILDING EPISODES



Precambrian time (the Proterozoic and Archean eons) was six times as long as the Phanerozoic eon, the period of obvious life.

Source: J.B. Bird, *The Natural Landscapes of Canada*.

the largest concentrations of population ensure that many Canadians have first-hand acquaintance with this uniquely Canadian environment. Nonetheless, population centres and transportation routes are largely restricted to the southern perimeter. The environment is generally hostile to man's activities and most of the Shield is unsettled, unproductive and unknown.

The Canadian Shield is a geologist's paradise. Most of it consists of the very old Precambrian rocks, about 80% of which are remarkably uniform granites of deep *igneous* origin. This fact accounts for much of the monotony of Shield scenery as exemplified by the Barrens. Towards the end of the Precambrian eon, sedimentary rocks — sandstones, limestones, and dolomites — were laid *unconformably* over the granites. Over a period of 3,000 million years (four times as long as the period during which life on earth has been identified) the rocks were *folded* and *faulted* again and again. Faulting brought contrasting rocks into contact with each other and subsequent *differential erosion* has resulted in the formation of some of the more spectacular scenery in the Shield. The fjord of the Saguenay River, the deeply dissected coast of Labrador and the striking *escarpment* marking the perimeter of the Shield along the north shore of the St. Lawrence River are all associated with faulting. Faulting has also been significant in the strong linear pattern of many Shield features — long straight valleys, lakesides and *scarps*, often with right-angled bnds.

Intense heat and pressure have changed, or metamorphosed, many of the rocks. Thus granites, limestones, and shales have become gneisses, marble, and slates. Amid these incredibly ancient metamorphosed sedimentary and volcanic rocks, scientists have identified portions derived from the erosion of even older land masses. Professor J.B. Bird has observed that "it is a fascinating thought that, in and among the *batholiths*, we may hit upon a fragment of the first surface, formed as the earth cooled."⁶ Some of these ancient rocks, particularly the metamorphosed lavas known as greenstones, are rich in metallic minerals.

The end of the Precambrian period was also the end of major mountain building in the Shield, which for the past 1,000 million years has remained the rigid nucleus around which the continent has developed. Only the very top-most of the Precambrian strata contain any indications of primitive plantlife, but the sedimentary rocks, which were laid down in the seas which have extended over the area at various times since, are rich in fossil remains. Where this cover has been removed, the old Precambrian core has been exposed and forms the Canadian Shield we know today. An almost equally large area of Shield structure lies buried beneath younger sedimentary rocks.

The exposed Shield has been subject to a very long period of erosion. Summits seldom exceed 600 metres and the relief is generally subdued but nonetheless rugged. Many features in the landscape are the result of recent glaciation. Boulders, sand, and gravel embedded in the ice scoured away the weathered mantle, "sandpapered" the rocks into smoothly rounded contours and gouged and deepened hollows of all shapes and sizes ranging from superficial scratches, or striations, to deep rock basins. Bare rock with waterfilled hollows is one of the characteristic features of the Shield landscape as is *stoss and lee relief*, with

⁶ J.B. Bird, *The Natural Landscapes of Canada*, p. 6.



Figure 5: *Water, rock and boreal forest are the characteristic features of the Canadian Shield. This is the Montreal River, Algoma region, Ontario.*

asymmetrical profiles, which developed in hilly areas where slopes facing the oncoming ice were gently moulded, in contrast to the abrupt, craggy slopes of the leeward side.

As the ice sheets slowly melted, millions of tonnes of boulders, gravel, and sand were dumped in haphazard fashion. Thus patches of *till* (unsorted material sometimes moulded into the characteristic forms of *moraines*, *drumlins*, and *kames*) are widespread throughout the Shield. These deposits often contain "erratic" boulders which have been transported far from their places of origin. Streams and rivers twist and turn through all this debris seeking a passage to the sea. Falls and rapids abound (see figure 5) since the streams have had insufficient time to carve out a gently sloped bed. Long, narrow lakes are common where pre-glacial valleys have been dammed by glacial deposits. More water is trapped in the innumerable bogs and swamps.

Almost one third of the surface of the Canadian Shield is now covered by water but an even greater proportion was under water in

immediate post-glacial times. Huge lakes were ponded up along the edge of the ice and the sea invaded parts of the land that were depressed by its great weight. Glacial debris was washed into these lakes and seas where it was deposited. Those that later drained formed the only significant areas of relatively level land in the Canadian Shield. Thus the clay-covered lowland of Abitibi County, Québec, and the Cochrane district of Ontario were laid down in Lake Barlow-Ojibway and the St. John Lowland in an arm of the Champlain Sea (see page 20).

Most of the Shield experiences a boreal climate (see figure 6) with long cold winters and short, cool summers. Weather conditions are dominated by the great masses of cold, dry air (see figure 7) which form over the frozen ground of the far north. Outblowing airstreams from these high pressure systems cover the Shield (and most of the rest of Canada) during the winter months, keeping temperatures low (see figure 8) for the latitudes. Thus at White River, Ontario, a record low temperature of -58°C has been noted, and the average January temperature for Kapuskasing, Ontario is -18°C . (Both stations are about the same latitude as Vancouver, British Columbia, Penzance, England and Prague, Czechoslovakia, none of which records an average January temperature below freezing.)

The Arctic air masses are less strong in summer and long hours of daylight help raise the average daily temperatures. Incursions of warm air from the Gulf of Mexico can cause very hot weather. Chicoutimi, P.Q., once recorded a high temperature of 40°C . However, invasions of arctic air are equally common and average summer temperatures in the boreal zone reach only to the mid-teens. Canada is noted as a country of two seasons, determined by temperatures, and it is in the Shield that these extremes are most clearly differentiated: the annual range of temperature at Schefferville, P.Q., for example, is 36°C , at Chicoutimi, P.Q. 34°C , at Kapuskasing, Ontario 35°C .

The western section of the Shield occupies the centre of a great land mass. Far from sources of moisture it receives only light precipitation. This ranges from 25 to 45 centimetres annually, almost half of it in the form of snow. The eastern part, however, receives about twice as much. Many storms are generated by the interaction of contrasting polar and tropical air masses along the polar *front*, particularly in the area of the Great Lakes. These systems drift eastward finding a natural route along the St. Lawrence Valley. They drop their moisture when forced to rise by the upland elevations along the edge of the Shield. Very heavy snowfalls often occur to the north of Québec City.

The growing season here is very short, only 90 or 100 days on the average, even in the most favoured parts. Cold air sweeping south in the late spring or early fall can shorten the actual frost-free period even more. Trees are smaller and grow more slowly than in the milder climates of the Pacific coast and the South. Only hardy agricultural crops, such as hay, pasture and roots can be economically produced. Dense forests (see figure 9) cover the southern part of the Shield. Maple, birch,

Figure 6



CLIMATIC REGIONS

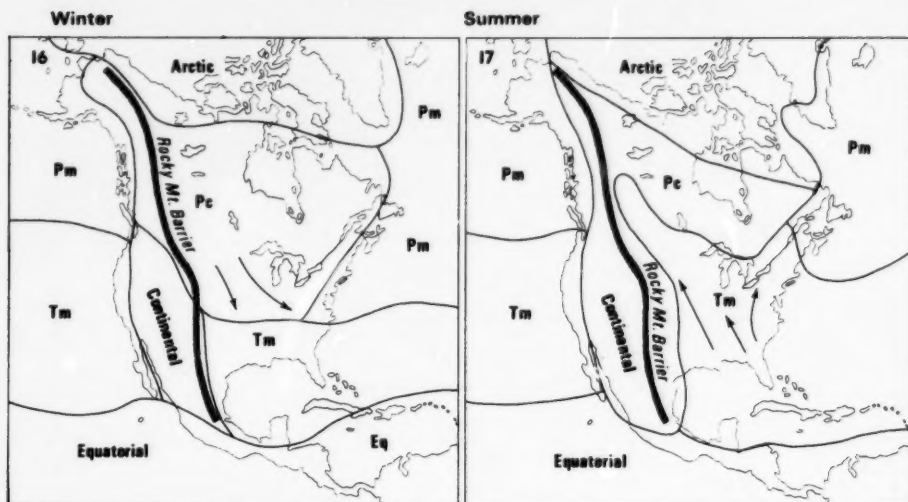
KEY for KOEPPEN REGIONS

-  Bsk middle latitude steppe
-  Csb dry-summer subtropical
-  Cfb marine west coast
-  Dfa humid continental, warm summer
-  Dfb humid continental, cool summer, no dry season
-  Dfc sub-Arctic
-  ET tundra
-  EF ice cap



Source: D.Q. Innis, *Canada: A Geographical Study*. McGraw-Hill, Toronto, 1966.

Figure 7 AIR MASSES OF NORTH AMERICA



Tm (Tropical Maritime) air is fairly warm and damp.

Pm (Polar Maritime) is cool and damp.

Equatorial is hot and damp.

Arctic is cold.

Pc (Polar Continental) is found over the continent and is cold and rather dry.

Pm (Polar Maritime) is cool and rather dryish but gives rise to showers.

In winter **Pc** covers much of North America but in summer the warm damp **Tm** pushes far north. The maps show how the **Pc** and **Tm** expand and shrink alternately through the year. Where air masses of very different characteristics meet, **fronts** are found.

Source: Grahame C. Waters & Miles A. Carter, *North America*.

and aspen — the favourite food of the beaver — are common Shield trees. It is in these regions that the brilliant fall foliage appears at its brightest. Northward, the deciduous trees are gradually replaced by conifers and long hours of weak sunlight have produced tall slender trees (mostly spruce and balsam) which are well suited to the production of pulp and paper. North of 50° N the commercial forest gradually thins out to subarctic woodlands and eventually to the treeless tundra.

Soil has been able to develop to any significant extent only where glacial deposits have covered the Precambrian base. (see figure 10) Plant and animal matter decomposes slowly in the low temperatures, and the *podzol* soil which does form is usually nutrient-poor because the mineral salts are leached away by the moisture that remains constantly in the poorly drained, chilly earth.

Figure 8

SELECTED CLIMATIC DATA FOR TWO STATIONS IN THE CANADIAN SHIELD

Kapuskasing, Ontario

	J	F	M	A	M	J	J	A	S	O	N	D
Temp. (°C)	-18	-15	-9	0	14	17	16	10	5	-5	-14	
Precip. (cm)	5	4	5	5	8	9	8	9	9	7	8	6

Schefferville, Québec

	J	F	M	A	M	J	J	A	S	O	N	D
Temp. (°C)	-23	-21	-14	-6	2	9	13	11	6	-1	-9	-18
Precip. (cm)	5	4	4	4	4	9	9	9	8	7	6	4

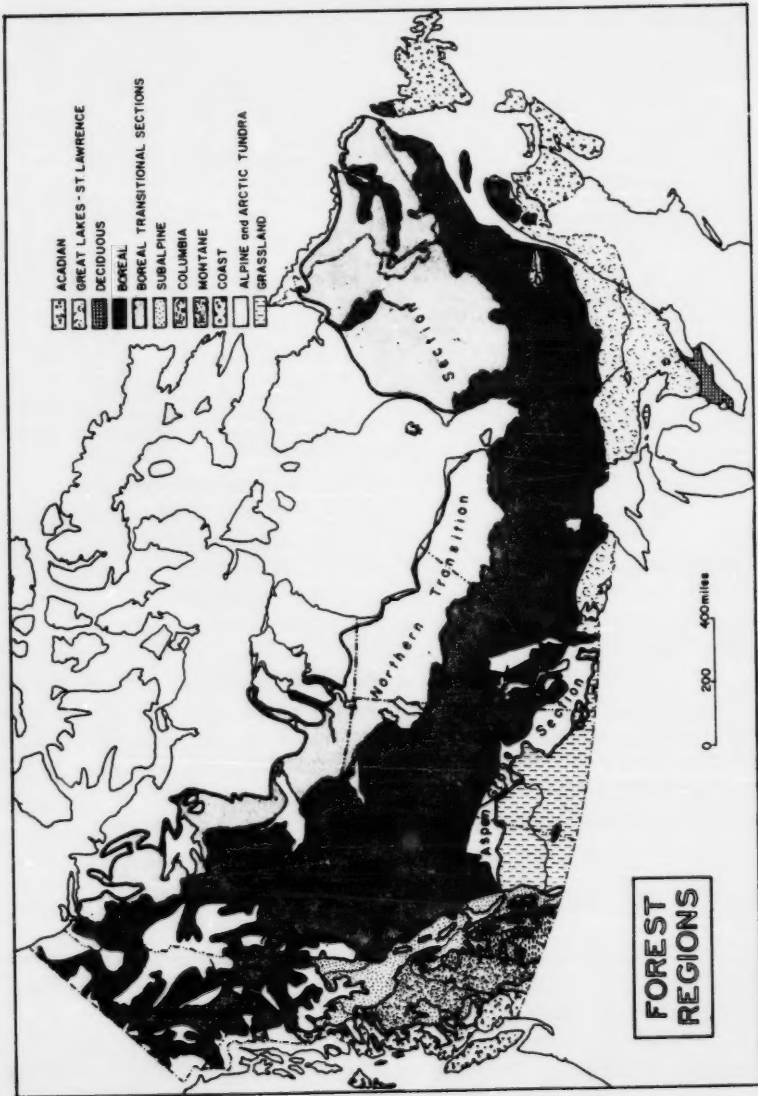
The Shield presents a generally forbidding environment. This vast expanse of difficult terrain has restricted settlement to its peripheral areas and interposed a barrier between the long-established settled areas of the East and the burgeoning West. It was one of the most difficult sections for the construction of trans-continental communication lines. At one point seven layers of railway track lie buried in the muskeg and two locomotives have been swallowed up. It was not until the 1960s that a paved road was completed around the north shore of Lake Superior.

Although unattractive to agricultural settlement, the Shield yields abundant resources. The rivers, lakes and falls provide industrial water and hydroelectric power; the treed area yields a wide variety of forest products; the mountains and waters provide valuable recreation areas and the ancient rocks are rich in minerals. Although settlement and development are necessarily isolated and scattered, the Shield is nonetheless a valuable and unifying factor in the existence of Canada.

The Great Lakes — St. Lawrence Lowlands

Bordering the Canadian Shield is a great arc of structure formed from sedimentary rocks deposited in the floors of the seas which once covered the old land mass. It seems likely that the Shield was sometimes completely submerged. Geologists see strong resemblances in the structure of the rocks which form the Interior Plains to those of the Hudson Bay Lowland and have also identified outliers of similar rocks on the surface of the Shield which may be remnants of a once continuous cover. At other times the Precambrian rocks certainly remained above the waves and material eroded from them washed down into the surrounding seas. It is thought that three *geosynclines*, or elongated seas, developed on the flanks of the Shield: the Appalachian-Acadian geosyncline in the east,

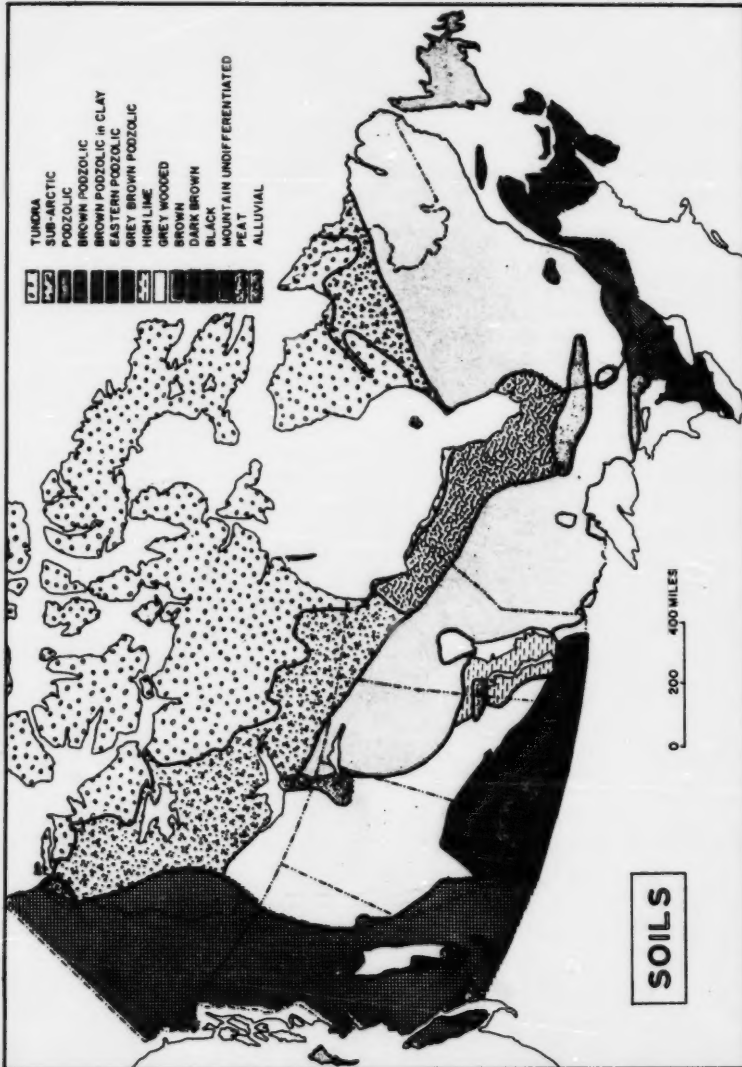
Figure 9



Source: D.Q. Innis, Canada: A Geographical Study.

the Cordilleran geosyncline to the west and the Franklinian geosyncline on the northern flank. Enormous thicknesses of sediments which accumulated on the floors of these geosynclines have since been folded and

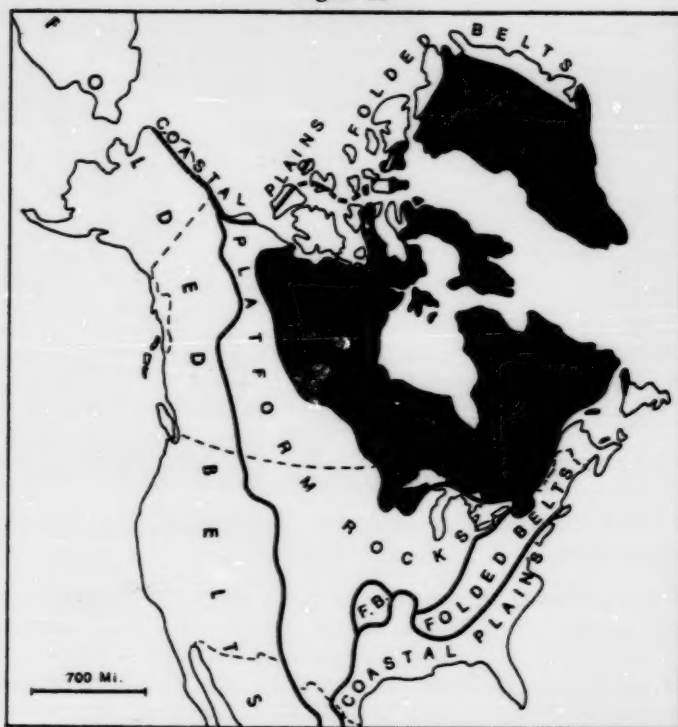
Figure 10



Source: D.Q. Innis, Canada: A Geographical Study.

faulted, (see figure 12) uplifted and intruded to form the sedimentary platform and the folded belts which comprise most of Canada outside the Shield.

Figure 12



Source: J.B. Bird, *The Natural Landscapes of Canada*.

The Canadian Shield: the heart of the continent, surrounded by platform rocks (buried Shield), folded belts, and coastal plains

The Canadian portion of the plateaux and plains, which extent from Anticosti Island to the eastern shores of the Queen Elizabeth Islands, fall naturally into two major sections: the Interior Plains and the much smaller Great Lakes — St. Lawrence Lowlands. Squeezed in between the old mass of the Shield and the mountain structures of the Appalachian system are the Lowlands divided into two distinct Great Lakes and St. Lawrence sectors by the Frontenac axis — a southeastward projection of the Shield which forms the Thousand Islands where it crosses the St. Lawrence.

In the Montreal area the St. Lawrence Lowlands (see figure 13) are spectacularly flat with the exception of the Rigaud, Oka and Monteregian Hills, which have developed where *outliers* of resistant igneous rock have been *intruded* into the *platform rocks*. Exposures of *sedimentary bedrock* are rare, (see figure 14) and are usually associated with areas affected by earth movements. Thus sandstone plains are exposed in Chateaugay County, P.Q. near the Beauharnois axis and limestone

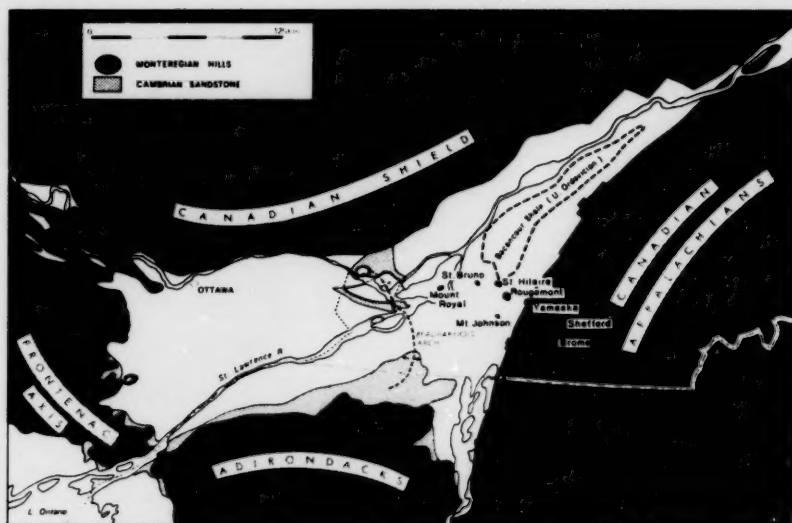


Figure 13: The Monteregian hills are outliers of resistant igneous rock intruded into the platform rocks.

plains and plateaux occur near the Frontenac axis. Limestone is also exposed on the sides of Mount Royal in Montreal. The platform rocks have been subject to prolonged *denudation* and have also experienced several glaciations. Bedrock and glacial deposits are buried beneath the sediments laid down on the floor of the Champlain Sea, which was formed about 11,800 years ago when the ocean invaded the Lowlands after the withdrawal of the ice, and in the *deltas* which were formed by the rivers which washed off the surrounding uplands.

After the sea withdrew the clays were exposed to form flat, ill-drained plains and the sands were quickly moulded into dunes. Streams cut rapidly into these unresisting materials and the chief variants in the monotony of the Lowlands are river valleys about 16 metres deep. In some places the rivers have cut through the sandy deltas and exposed the buried marine clays creating a landscape of sandy plateaux separated by channels of ill-drained peat bogs. this type of scenery is well developed east of Lachute, P.Q. Elsewhere the more resistant bedrock has been exposed, and rapids, which became very significant in the settlement of the area, developed. Below the rapids the sands and clays have been swept away by rushing waters and ice, and wide shallow pools or basins have been formed as at Laprairie below the Lachine Rapids and at Chambly on the Richelieu. Other significant variants in the scenery are the many raised terraces and beaches. Relieved of the great weight of the ice the land was already rising steadily during the invasion of the Champlain Sea and the shorelines were elevated some 150 metres above the present sea level. The striking bluff, 45-55 metres high, which separates Montreal's downtown and uptown is part of the shoreline of the Champlain Sea.

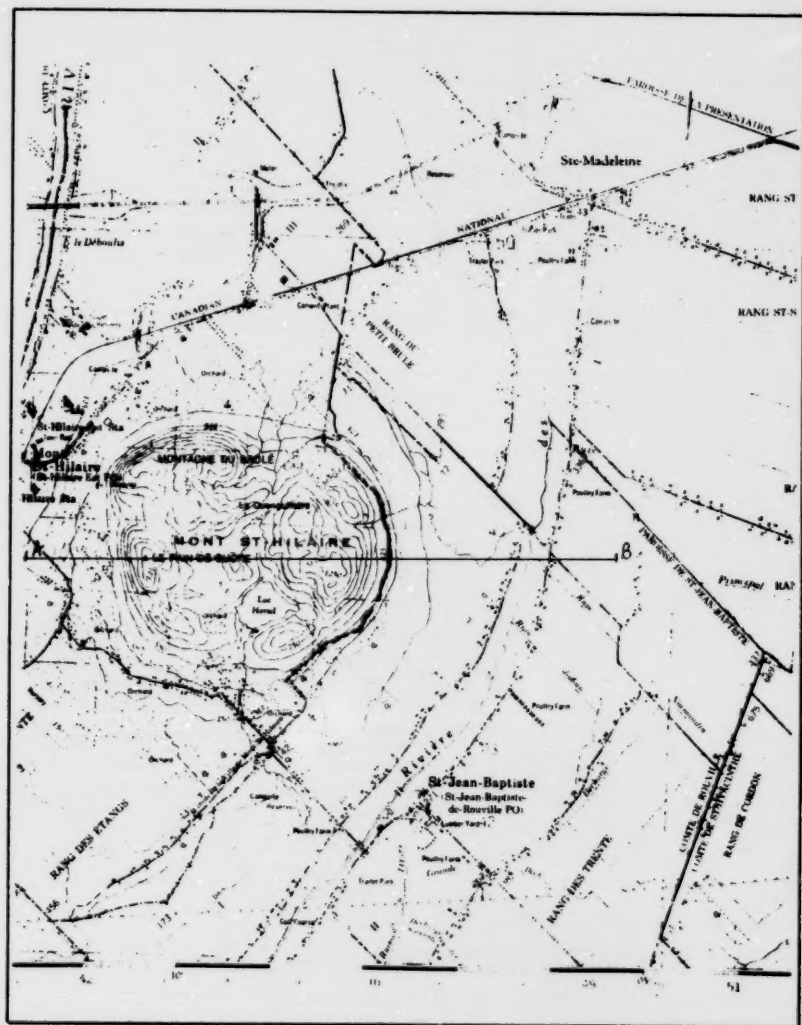


Figure 14: Part of the St. Lawrence Lowlands near Montreal, Que.

Closed contours, closely packed, rising from 125 ft. to 1,250 feet in one mile, indicate the steep-sided mass of Mont St. Hilaire which dominates the map as it does the countryside. All around lies the very flat Montreal Plain, only about 100 feet above sealevel. This is indicated by the almost total absence of contours, the numerous, very straight roads and railway and the presence of many very small streams and drainage ditches. The quarry on the north side of the mountain and the presence of a cement plant nearby are further indications of the geological nature of the mountain. There is overwhelming evidence that this is a productive, densely settled rural area.

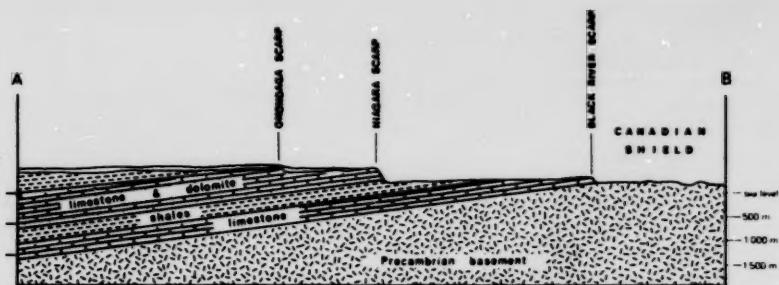


Figure 15: A geological section across southwestern Ontario showing the major scarps and the increasing depth of the Shield in the southwest corner of the province.



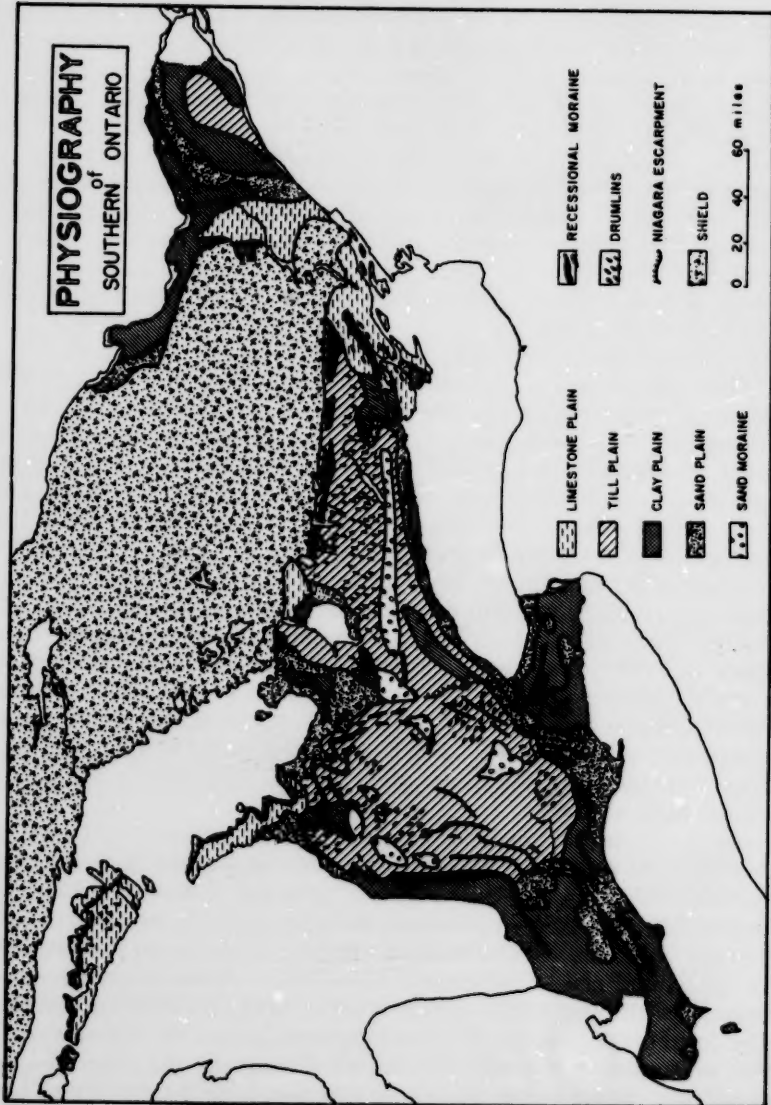
Figure 16: The major escarpments of southern Ontario.

Source: J. B. Bird, *The Natural Landscapes of Canada*.

Earthflows develop along bluffs and banks where sand overlies clay, cover considerable areas. Over 700 of these have been mapped, some covering several square miles. Farmland, buildings, and lives have been lost as a result of these flows.

In the Great Lakes or Southern Ontario section of the Lowlands the bedrock is likewise largely buried beneath a deep layer (see figure 15). This more recent, largely unconsolidated material is mostly debris left behind by melting ice. However, the underlying structure is apparent in the development of a distinctive landscape. In this area the layers of sandstones, limestones and shales which make up the bedrock were tilted gently westward. Thus each layer disappears beneath that laid down on top of it, the oldest rocks appearing at or near the surface in the eastern part. During the prolonged periods of erosion the less resistant rocks,

Figure 17



Source: D.Q. Innis, Canada: A Geographical Study.

mostly shales, have been worn away more quickly leaving the edges of the more resistant to form east-facing scarps. The most prominent of these is the Niagara scarp, capped by Lockport dolomite. The differential erosion of the various layers of rock is particularly well demonstrated where they

have been exposed in the Niagara Gorge. Over most of the area, however, the scarps have been so worn down by ice and covered by drift as to be scarcely recognizable. The *dip* slopes or vales which are complementary to the scarp faces are even more difficult to identify. They are either drowned, like the dip slope of the Black River scarp in Georgian Bay, or buried by glacial deposits. Ice advanced over this area several times and the deposits of debris left behind are often more than 16 metres deep, completely burying the underlying rocks. Rough bouldery moraines, hummocky expanses of ill-drained till, smoothly contoured drumlins, rugged eskers and flat sand and clay plains (see figure 17), the legacy of preglacial lakes, abound. The most conspicuous effect of the glaciations was the creation of the Great Lakes when the outlets for the water which had accumulated in the broad trough between the Canadian Shield and the Appalachians were blocked by glacial deposits.

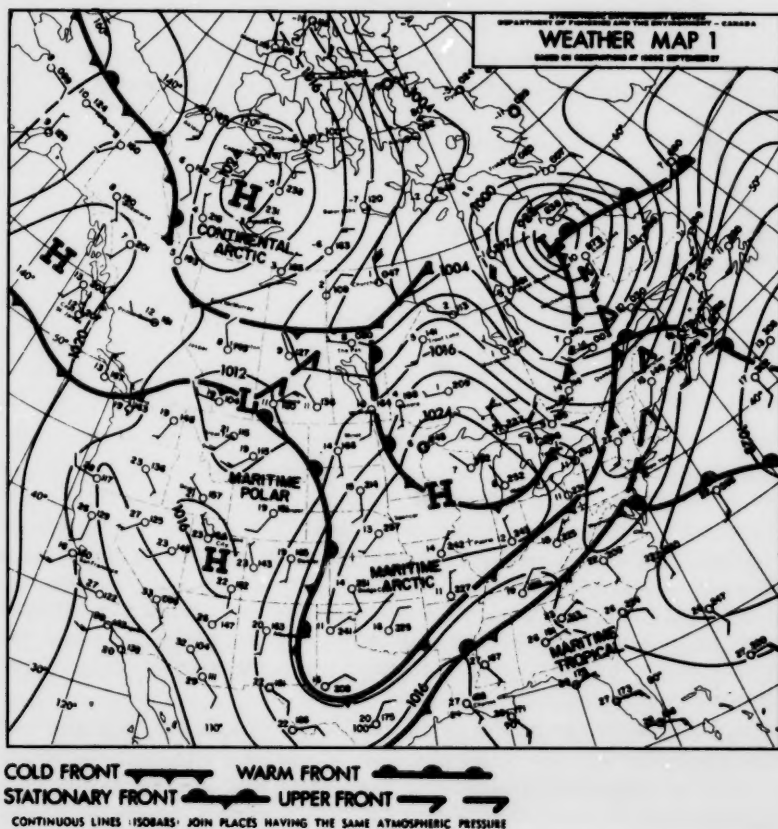
Appalachians were blocked by glacial deposits.

The Great Lakes — St. Lawrence Lowlands are something of a battleground where the contrasting Arctic (cold and dry) and Gulf (warm and moist) air masses interact. With sometimes one, sometimes the other, in the ascendant. With frequent instability as the airs mix, the Lowlands experience a wide variety of weather. With the influx of Arctic air, skies clear and temperatures fall bringing dry cold in winter and welcome relief from near tropical heat in summer. Gulf air is responsible for muggy days and high humidity. The interaction of contrasting air masses creates unstable conditions and thunderstorms, ice storms, blizzards and dense fogs are common. Furthermore, the Lowlands corridor offers an easy route eastward for storms originating from a similar mixing of air in the heart of the continent. Low pressure systems, depressions or cyclones, move rapidly across the area bringing steady rain or snow as the warm front passes. After a slight clearing a drop in temperature and intermittent precipitation follows as the cold front follows through.

Conditions in the Lowlands are generally less extreme (see figure 19) than those of the Shield. Summer temperatures are very high: the average temperature in July at Toronto is 22° C and a record of 40° C has been reached. Winter temperatures, however, are less severe: 4° C is the average for January in Toronto, largely because of the latitude. Temperatures generally become cooler from Windsor to Montreal because of the southwest-northeast trend of the St. Lawrence Valley. The constant procession of weather systems across the region ensures that precipitation is evenly distributed throughout the year. *Convective* rain, caused by the cooling air that rises from the overheated land surface, provides additional moisture in summer when it is most needed for crops.

With adequate precipitation and relatively warm temperatures, hosts of soil-forming micro-organisms are present. The parent materials of sand, clay and till are enriched by decomposing organic material. The natural vegetation of mixed coniferous and deciduous forest has been

Figure 18



almost completely removed and much of the land is well suited for farming. The region is strategically located for the easy assembly of raw materials, particularly by the Great Lakes-St. Lawrence waterway, and for the marketing of its products. It is not surprising that the Lowlands have become, agriculturally and industrially, the most productive region of Canada and are often referred to as the heartland.

The Interior Plains

In the Interior Plains section of the sedimentary platform the Precambrian rocks are buried deeper, the sedimentary layers are flatter and the glacial mantle thicker than in the Great Lakes Lowland. Furthermore, the weather is hotter, colder and drier. Nevertheless, "were it not for the accident of the Canadian-United States border, the landscape

Figure 19

SELECTED CLIMATIC DATA FOR TWO STATIONS IN THE GREAT LAKES — ST. LAWRENCE LOWLANDS

Montreal, Québec

	J	F	M	A	M	J	J	A	S	O	N	D
Temp. (°C)	-10	-0	-3	6	13	19	21	20	16	9	2	-7
Precip. (cm)	8	8	8	7	7	8	9	8	8	8	8	9

Toronto, Ontario

	J	F	M	A	M	J	J	A	S	O	N	D
Temp. (°C)	-4	-4	0	7	13	19	22	21	17	11	4	-2
Precip. (cm)	7	6	7	7	7	6	7	6	6	6	6	6

resemblances between southern Ontario and southern Manitoba would be more evident to Canadians than they are.”

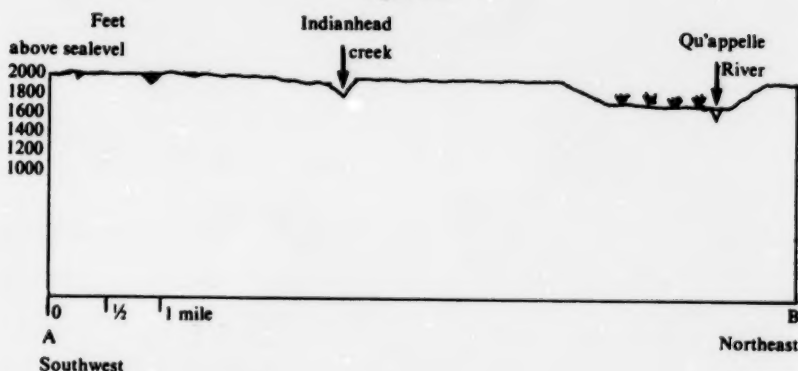
Although the physiographic structure of the Plains remains similar for some 2,500 km from the U.S. border to the Western Arctic, it is convenient for descriptive purposes to discuss the northern section as part of the Arctic Lands. The southern or Prairie section corresponds mainly to the Saskatchewan *watershed* and the prairie grassland and parkland vegetation belts.

In the Prairies the Shield rocks are buried deeply beneath the sedimentary layers with no visible effect on the scenery, although the underlying structures are significant in the search for oil. As in southern Ontario the sedimentary platform has been gently tilted westward and the erosion of less resistant rocks has exposed a series of east facing scarps separated by wide plains. Thus the oldest of the sedimentary rocks are the limestones and dolomites of the Manitoba Lowland (First Prairie Level). The hills of the Manitoba Escarpment, which have been formed where the edge of the overlying shale is exposed, separate the Manitoba Lowland from the Saskatchewan Plains (Second Prairie Level). A similar escarpment, the Missouri Coteau, separates the Saskatchewan Plains from those of Alberta (Third Prairie Level) which have developed on still younger shales. Most of the bedrock is buried deeply beneath a cover of glacial *drift*. It is a significant element in the landscape since the major relief features are located where the bedrock is nearest the surface.

Great rivers are also an important feature of the Interior Plains, whereas the Shield is characterized by many short rivers and streams in a disorganized pattern, the Plains exhibit a well-developed system of a

¹J.B. Bird, *The natural Landscapes of Canada*, p. 2.

Figure 20



Section across part of the Interior Plains

few master rivers and tributary streams which are a major integrating factor in the region. The sedimentary shales and limestones are easily eroded and *consequent streams* established themselves on the gentle slope towards the northeast. It is thought that the whole area once drained through Hudson Bay but that vigorous *head erosion* by the Mackenzie and Missouri-Mississippi systems resulted in capture. Thus the Liard, Hay, Peace and Athabaska rivers now drain northward. Of the old consequents only the Saskatchewan continues to drain eastward and geomorphologists think its waters too will ultimately be diverted to the Mackenzie. Only in the Manitoba Lowland are there any natural lakes of significant size. Over the rest of the Plains the combination of well-drained soil and low precipitation keeps lakes small and intermittent.

In the Manitoba Lowland the limestones outcrop to form low plateaux such as the Interlake Plateau, between Lakes Manitoba and Winnipeg, and low dolomite scarps such as those north of The Pas, Manitoba, which closely resemble those of southern Ontario. Most of the landscape, however are formations reminiscent of those left by the Champlain Sea: an incredibly flat, clay plain with sandy deposits and elevated beaches. These are the legacy of glacial Lake Agassiz and the glacial delta of the Assiniboine River. Further north are other familiar landforms of a recently glaciated area: great quantities of water trapped in shallow basins, often blocked by glacial debris, moraines, marshes and muskeg.

The bedrock dips very gently westward and eventually the Manitoba Lowland disappears beneath the scarp front of the overlying shales. The exposed edge of this layer, known as the Manitoba Escarpment, can be traced for 800 kilometres from the Pembina Hills of the United States border to the Wapawekka Hills of north-central Saskatchewan. In Duck Mountain Provincial Park and in the Porcupine Hills the

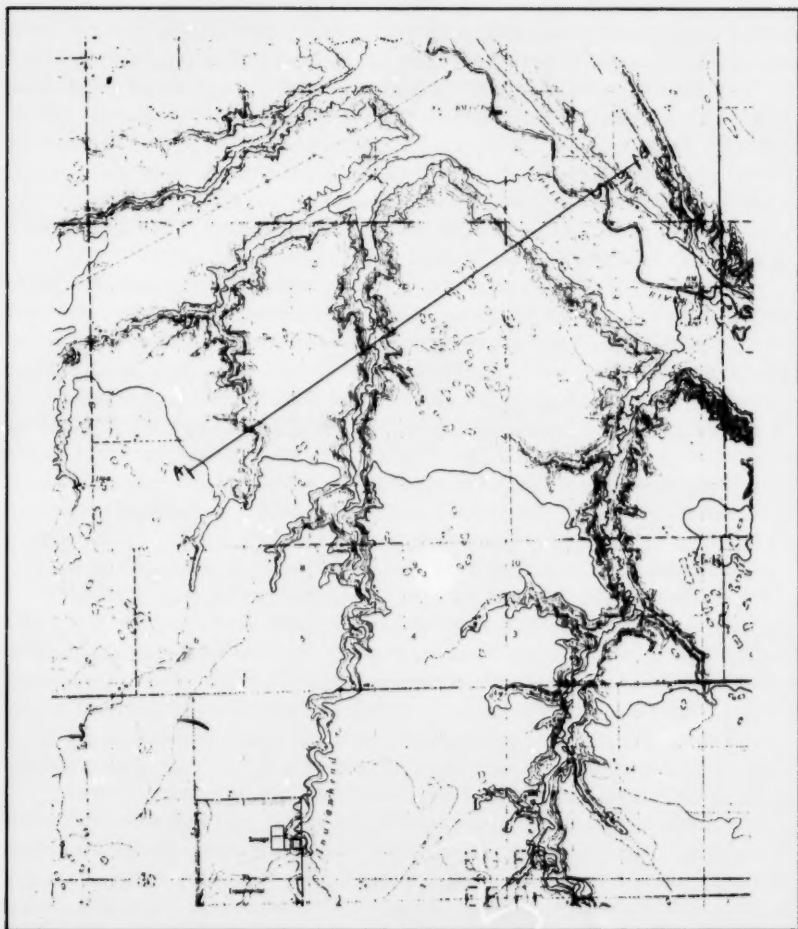


Figure 22: Part of Saskatchewan Plains near Indian Head, Sask.

The generally flat nature of the Saskatchewan Plains, about 1,820 - 1,900 feet above sealevel, is indicated by very widely spaced contours. The gradient on the plateau surface is about 25 feet for every two or three miles. Very steeply sided valleys, shown by closely packed contours have been cut about 200 feet down into the plain. The straight, flat-floored valley occupied by the Qu'Appelle river is about a mile wide and is occupied by only a narrow, winding stream. Much of the valley floor is marshy. Tributary valleys are narrow and steep-sided. Green shading on the original map indicates that woodland is confined almost entirely to the valley sides. Large numbers of tiny intermittent lakes are indicated on the plateau surface. Sparse but regularly spaced settlement on the plains plus the presence of the Experimental Farm at Indian Head suggest agricultural settlement on large units.

Escarpment reaches elevations of about 900 metres but it is more spectacular in the south where it rises suddenly and unbroken from the Red River plains. It consists mainly of groups of hills separated from each other by streams such as the Swan, Dauphin and Assiniboine which cross the Escarpment, and from the main expanse of the Saskatchewan Plains by wide river valleys, particularly that occupied by the Assiniboine. These hills have been further modified by glacial action and by local stream activity. The lakes and forests of these upland areas are particularly valued for recreational purposes.

The scenery of the Saskatchewan Plains results almost entirely from recent glaciation. The influence of the underlying structure is apparent where upfolds bring the bedrock closer to the surface and contribute to the formation of slightly higher areas of rough terrain such as Moose Mountain and the Tiger Hills. The nature of the bedrock also influences the drift itself. Where the ice was established over unconsolidated and semi-consolidated rocks, as it was in the Prairies, the cover is much thicker than over the more resistant rocks such as those of the Shield. The low, hummocky ridges, the numerous marshes and sloughs and the remarkably flat *lacustrine plains* (figure 20) which cover southern Saskatchewan are familiar features of glacial deposition. West of the Manitoba Escarpment the Prairies are characterized by deep, broadbottomed valleys (see figure 21) which have been carved into the till. They are usually about one to two kilometres wide with steep sides, anywhere from 7 to 140 metres high. Some are occupied by major rivers, notably the Saskatchewan, but many carry only small water-courses which could not possibly have carved such huge channels; some are completely dry. It seems reasonable to assume that such valleys were formed as spillway to drain the meltwaters from the great ice sheets.

The Missouri Coteau is even more fragmented than the Manitoba Escarpment. Geologists think that it was never a very conspicuous formation. Because it was protected only by the natural grassland of the arid areas of southern Saskatchewan, it has been deeply eroded. It can be traced as a series of low hills across southwest Saskatchewan but disappears completely beneath the glacial deposits of eastern Alberta.

The pattern of deeply *entrenched valleys* crossing great expanses of glacial drift is repeated once again in the Alberta Plains. However, the extreme aridity of the southern part and the proximity to the intensely folded region of the Western Cordillera have resulted in the formation of distinctive landforms. In areas of extreme aridity some of the valleys carved by the meltwater streams have been preserved as spectacular *coulées* and rapid erosion of other valley sides has produced striking *badland* topography. Remnants of the layers of material washed down from the Cordillera following the last mountain building rise above the general level of the Alberta Plains. These rolling, deeply dissected uplands, which include Wood Mountain and the Cypress Hills, provide welcome variety in the sometimes monotonous plain. The Cypress Hills in particular, with clear streams and wooded slopes, are in sharp con-

trast to the surrounding short-grass prairie and sagebrush. In the extreme west the sediments of the plains have been faulted in association with the earth movements which formed the Cordillera.

The climate of the Plains is much more extreme (see figure 23) than that of the Great Lakes Lowlands. Winters are considerably longer and colder and summers are almost as hot. Mean temperatures for January and July respectively at Regina, for example, are -17°C and 19°C (compared with -4°C and 22°C at Toronto) and the frost-free period is 109 days (compared with 187 days at Toronto). In winter the extreme cold in the far north causes the buildup of a large area of intense high pressure. Vigorous outblowing winds stream south and for weeks or months at a time the Prairies are covered by continental arctic air. This region has the most liberal allowance of sunshine of any in Canada and under clear skies such heat as there is radiates freely. Furthermore, winter days are short in these northerly latitudes and the sun's rays are at a very oblique angle which further minimizes the amount of heat received. Thus Prince Albert once recorded a low temperature of -57°C — only six degrees above Canada's record low of -63°C (at Snag, Yukon Territory). The winds sweep unimpeded across the open, often treeless plains, and the "physiological" temperature is often considerably lower than that recorded with the shelter of the *Stevenson screen*. Close to the western mountains winter temperatures are considerably ameliorated by the Chinook, a local wind which is warmed by pressure as it descends the slopes. Thus Calgary, although 133 kilometres further north and nearly 800 metres higher above sealevel than Winnipeg, has an average January temperature 10 degrees higher. In midsummer when the sun is overhead at the northern tropic, the more direct angle of the sun's rays, coupled with longer hours of daylight, results in rapid heating of the northern continents. Interior areas, far from the moderating influence of the sea, heat particularly intensely. The continental arctic air mass retreats to the immediate vicinity of the pole and tropical continental air from the overheated southwestern United States extends far to the north bringing high temperatures to the Canadian Prairies. Thus Regina has experienced a record high temperature of 43°C . However the rapid escape of heat during the night lowers the average diurnal (24-hour) temperatures.

There are few sources of moisture in the middle of a large land mass and precipitation is generally low. During the winter cold air sits heavily over the Plains and winds tend to blow outward from the resulting high pressure system. The polar front, where the mixing of air masses produces the large numbers of depressions which account for most of the precipitation, is generally pushed far to the south. However, when moist air is drawn northward heavy snows and severe blizzards can occur in southern Saskatchewan and Manitoba.

In summer the heated land produces a low pressure centre and outside air is drawn in. Having travelled far from sources of moisture, the inflowing air brings only light precipitation. Most is *cyclonic* in origin;

Figure 23

SELECTED CLIMATIC DATA FOR TWO STATIONS IN THE INTERIOR PLAINS

Winnipeg, Manitoba

	J	F	M	A	M	J	J	A	S	O	N	D
Temp. (°C)	-18	-15	-8	3	10	17	19	19	13	7	-4	-14
Precip. (cm)	3	2	3	3	5	8	7	7	5	4	3	2

Regina, Saskatchewan

	J	F	M	A	M	J	J	A	S	O	N	D
Temp. (°C)	-17	-15	-8	3	11	15	19	18	12	5	-5	-12
Precip. (cm)	2	2	2	2	4	8	5	5	3	2	2	2

it is produced when the depressions which developed over the north Pacific and have dumped most of their moisture on the slopes of the Cordillera, draw into their orbit moisture from the east and south. Occasionally tropical maritime air from as far away as the Gulf of Mexico and the Atlantic is drawn in. *Orographic precipitation* accounts for the slight increase in upland areas. The Cypress Hills, for example, receive about five centimetres more than the surrounding area. Showery and sporadic *convection rains* are associated with rapidly rising temperatures in spring and in the hottest hours of the day. Manitoba gets the most precipitation, largely due to its southeasterly position closer to the source of moist tropical air and to the local effect of the large lakes. However Winnipeg receives an average annual precipitation of only 52 centimetres, compared with 78 centimetres at Toronto and 97 centimetres at Montreal. The amount of precipitation gradually decreases westward until in southwest Saskatchewan the average annual precipitation is only about 25 centimetres.

Precipitation is the source of numerous problems for the people of the Prairies. The average precipitation is low but the actual precipitation is often much lower and drought has been a major problem. Thus Outlook, Saskatchewan, while recording a mean annual precipitation of 30 centimetres, has experienced record annual low precipitation of 16 centimetres. Swift Current, Saskatchewan, where, based on average records 16 days of drought are expected on average in April, there has been no precipitation for as many as 46 consecutive days at that season. Furthermore, most of the precipitation falls in the summer months when high temperatures and dry winds reduce its effectiveness.

Paradoxically, the Prairies often suffer the effects of excessive moisture. Rapidly melting snow in spring can create shortlived but raging and highly erosive torrents. Floodwater may lie long and widespread over the frozen ground. Thunderstorms are frequent, due mostly to

local convection of air over heated ground. These storms average twenty days a year for most of the area and give rise to destructive torrential rain and hail. Hailstones are usually about a centimetre in diameter but can reach 10 centimetres and coverings of a foot deep have often been reported. Hail occurs only about two or three days a year but destructive hailstorms causing almost total crop failure can be expected every 10 years or so and crop insurance is an important factor in Prairie agriculture.

Annual precipitation in the Plains is generally somewhat scanty and is notoriously unreliable. But it comes during the growing season and falls on generally favourable terrain resulting in the development of productive soils clothed with grass and interspersed with small trees.

The greenest, most treed part is the horseshoe-shaped area around the west, north and east of the Prairies. This is the best watered area and supports scattered groves of aspen, black poplar and elm amid luxuriant long grasses. Many pioneers noted brilliant displays of wild flowers in these areas. Light rain percolating slowly through the accumulated debris of organic material has produced the rich black soil or *chernozem*. As precipitation decreases towards the heart of the Prairies the grass becomes shorter and less abundant, the humus cover is less deep and the soil becomes paler in colour. Except for watercourses and windbreaks the zone of chestnut or dark brown soils is almost treeless. However, if carefully cultivated, the area is agriculturally productive and corresponds in fact to the famous Canadian Wheat Belt. The driest part of the Prairies, the area of southwest Saskatchewan and southeastern Alberta, is often referred to as Palliser's Triangle after the British explorer. Here, low precipitation coupled with extremely high summer temperatures has resulted in the development of soils that are light both in texture and colour. Although quite fertile, these brown soils support only sparse growth of short grass, often with patches of bare soil between the plants. They can produce crops in years of adequate rainfall or when well-irrigated but the development of dust bowl conditions during the droughts of the 1930's made it plain that special practices are necessary if this area is to be agriculturally productive. Dry farming, summer fallowing, contour ploughing and the planting of windbreaks have proved beneficial. The best use seems to be as grazing land for livestock.

The Prairies offer a harsh environment and one that was very foreign not only to the immigrants from overseas but even to those from eastern Canada. Many settlers abandoned their homesteads but those who adapted themselves to the new challenges prospered. Prairie farmers learned that the wide open spaces and rather dry environment produce the best returns when farmed extensively. The economic units became larger and larger with fewer and fewer people required to work this land. Gradually the nation's most extensive area of agricultural settlement was established. It extends over a huge triangle measuring some 1,200 kilometres along its southern margin and stretching about 600

kilometres northward at its greatest extent. This area greatly exceeds that of the entire Great Lakes — St. Lawrence Lowlands. Agricultural settlement is distributed fairly evenly over this area. However, the three Prairie provinces together have only 8 centres with more than 35,000 people each, compared with 32 for Ontario and 15 for Québec. The Prairie cities of Winnipeg, Calgary and Edmonton, though growing rapidly, with about 500,000 people apiece present a very different milieu from the big eastern centres of Toronto and Montreal with three million people apiece or even Vancouver with just over one million. The Prairies feel dominated by areas with greater concentrations of population and having very different perspectives.

Furthermore, the produce of the Prairie Provinces, very little of which can be absorbed by regional markets, must pass through other parts of Canada in order to be sold. Thus the Prairie producer is vulnerable to a strike on the Vancouver waterfront or an unusually early freezeup in the St. Lawrence Seaway. The problems are intensified by the natural and political barriers which separate the Prairies from the rest of Canada. To the east lies the empty wasteland of the Canadian Shield, some of it in foreign territory. To the west rises the spectacular mountain barrier of the Cordillera. Paradoxically, the Prairies are in the heart of Canada but isolated from the rest of the country.

Appalachian Canada

Great thicknesses of sediments accumulated on the floors of the geosynclines which developed on the flanks of the old land mass of the Canadian Shield. It seemed unlikely that the Shield, which by Palaeozoic times had already been reduced to a region of low relief, could have provided such large quantities of material. Geologists have postulated the existence of vast land masses on the far sides of the geosynclines. The supposed continent of Acadia could have been part of Europe, since moved away in continental drift. The western equivalent, Cascadia, is even more of an enigma. Certainly the every-increasing load of sediments seems to have caused the earth's crust to sag to the point where the stresses could no longer be contained. The result was faulting accompanied by *vulcanism* and uplift. The great mountain systems of Canada are made up of folded, contorted sedimentary and volcanic rocks.

About 500 million years ago a major disturbance, the Taconic period of mountain building, caused intense folding accompanied by vulcanism in the Appalachian region. Great mountain ranges comparable to the present-day Rockies were pushed up along the Atlantic seaboard of North America. In particular, thick sediments from the centre of the geosyncline were thrust as much as 50 kilometres northwestward over the thinner sediments of the continental shelf. This Appalachian front, also known as the Champlain Fault or Logan's Line, although a major

structural boundary, is rarely conspicuous on the ground as it is often buried by drift. Erosive forces immediately attacked these Taconic mountains and sediments were once again washed down to accumulate on the sea floor. During the second, or Acadian, period of mountain building, granites, melted in the deepest part of the geosyncline, were pushed up to form the Acadian Mountains. Remnants of these remain in the Central Highlands of New Brunswick, the Atlantic Uplands of Nova Scotia and much of southern Newfoundland.

For hundreds of millions of years the forces of erosion have been working to level the landscape. Outlines have been smoothed and rounded and the highest elevation in Appalachian Canada is Mount Jacques Cartier in the Gaspé Peninsula at 1,268 metres. After such prolonged erosion it is not surprising that the major landforms of Appalachian Canada are residual features left after denudation has removed the less resistant materials.

In Québec ancient schists, many of them almost as old as the rocks of the Canadian Shield, outcrop to form the Sutton and Notre Dame Mountains. Some summits exceed 900 metres and where the schists have weathered into vertical slabs the landforms are very striking. The most rugged scenery is in the Gaspé where fault-line scarps of resistant granites and schists form the almost unbroken wall of the Shickshock Mountains. At the eastern end of the peninsula the coastline cuts across the strike of the folds and a pleasing juxtaposition of bays and headlands has developed in the areas around Percé. Igneous intrusions account for some of the conspicuous isolated summits of Québec's Eastern Townships, such as Mount Orford, Owl's Head and Mount Megantic and also for the presence of serpentine, the basis of the asbestos mining industry. Across southern New Brunswick and northern Nova Scotia there is a series of horsts or upfaulted blocks of Precambrian volcanic and metamorphic rocks. These form the Caledonian Uplands, the Cobequid Hills, the Pictou-Antigonish Highland and Cape Breton Island. Imposing fault-line scarps mark many of the edges of these blocks. The northern edge of the Caledonian upland, for example, is 200 to 300 metres high and extends largely unbroken for more than 80 kilometres. The southern edge of the Cobequid Hills forms spectacular cliffs overlooking Parrsboro, N.S. The interior areas of these block mountains present rolling uplands of low relief. They have been subject to long periods of erosion and remnants of several *peneplains* or erosion surfaces have been identified. Only low hills rise as *monadnocks* above the general level. However, river valleys are often deeply incised, especially near scarps where some flow in gorges. Where the upland mass reaches the sea in the Cape Breton Highlands, a spectacular cliff coast has developed (see figure 24).

Along the Atlantic coast a tilted block of resistant rocks forms an upland area which extends across the whole width of Nova Scotia. The northern edge is marked by a conspicuous fault line scarp, of which the South Mountain is a part. During the Acadian mountain building the

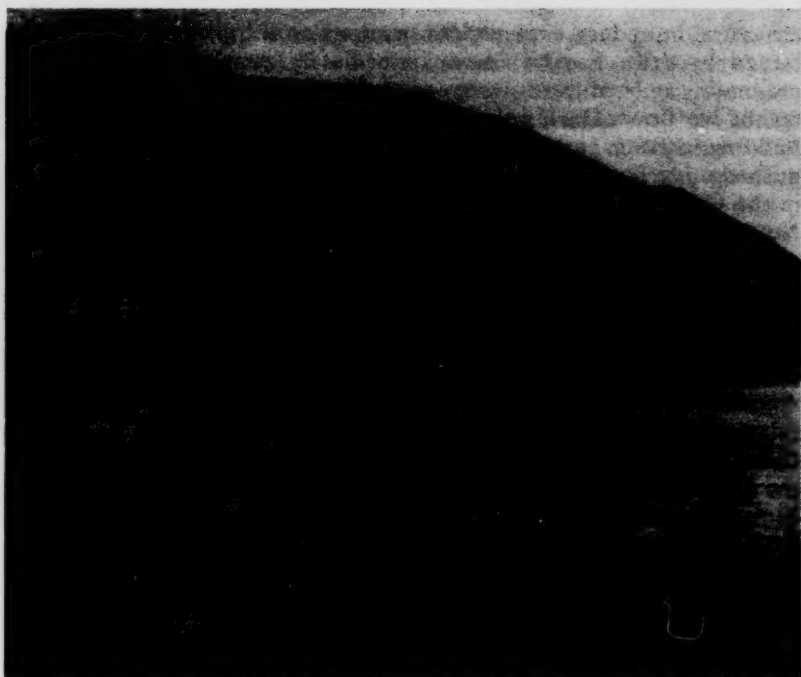


Figure 24: *Where the Appalachian Mountains meet the sea — the Cabot Trail, Cape Breton Island, N.S.*

older rocks were metamorphosed into shales and quartzites, and the fold pattern has imparted a strong grain to the landscape. Long narrow peninsulas and islands such as those near Lunenburg, N.S. and Wedgeport, N.S. are noticeable reminders of this folding. The massive granites, which are dominant in the region, were intruded at the same time. In some places, particularly in the area between Halifax, N.S. and the Avon estuary, streams have dissected the upland into a series of hills. Over large stretches, however, the terrain is rather flat.

The Long Range Mountains of the Northern Peninsula of Newfoundland is also a tilted block of Precambrian rock with a gently undulating surface on which several levels of erosion have been identified and a spectacular plateau edge. The southern part of the Long Range is a conspicuous *fault-guided scarp* developed largely on granitic intrusions.

Since the formation of the Acadian Mountains there has been time for the accumulation of considerable quantities of sediment largely derived from the erosion of these mountains. Sandstones, shales and some coal measures were deposited in local basins and have been easily eroded to underlie most of the lowland areas of the Atlantic region. The plain or Maritime Basin of eastern New Brunswick, northern Nova Scotia and Prince Edward Island consists of generally flat-lying sedi-

ments but gentle folds and dips have produced low scarps in some places, particularly on Prince Edward Island. Anticlinal structures underlie parallel ridges in the southern New Brunswick valleys of the Salmon and Canaan Rivers and in northern Nova Scotia around Springhill. Except for the entrenched valleys the plain is generally very flat and where it has been invaded by the sea there are long, narrow estuaries, lagoons and offshore sand and shingle bars. Fine examples can be seen in Kouchibouguac National Park, N.B. In a few places, such as the Bay of Chaleur and the north side of Prince Edward Island, spectacular red cliffs have been formed where the low sandstone plateaux reach the sea.

A smaller lowland area has developed on the sandstones, conglomerates and shales of the Annapolis Formation. Overlying basaltic lava flows, parts of which remain to form the escarpment of the North Mountain, have been largely removed and the Annapolis Valley Lowland has been exposed. Much of the low lying land is now submerged beneath the Bay of Fundy, the Annapolis Basin and St. Mary's Bay. In the lee of former offshore ridges, the exceptionally high tides of the Bay of Fundy (sometimes exceeding 14 metres) have deposited mud which was subsequently stabilized by salt marsh as at Grand Pré, N.S. These marshes, the only treeless ground in the seventeenth century, supported the earliest European settlement in Canada and remain prized agricultural land today.

Of particular significance are the coal measures which were formed when the sea withdrew from the geosyncline following the last period of mountain building. Luxuriant forests clothed the swampy plains that were thus exposed and gradually the coal deposits, of which considerable quantities remain in Cape Breton Island and northern Nova Scotia, were built up.

Although the major elements in the Appalachian landscape were present before glaciation many of the structures are masked beneath the deposits of the Pleistocene ice sheets. *Glacially over-deepened valleys*, often blocked by glacial deposits have filled with water to form the attractive lakes Magog, Memphremagog, and Massawippi in Québec. Drumlin fields are particularly well-developed on the Atlantic Upland of Nova Scotia. *Outwash sands*, lacustrine clays and windblown *loess* remain in the Annapolis Valley and throughout the Appalachian region large areas are covered by some form of undifferentiated drift. Submerged extensions of the land form a wide continental shelf where the shallow waters, particularly over the banks formed by the deposition of debris contained in melting ice, form some of the world's most valuable fishing grounds.

The combination of mountain and maritime influences causes a great variety of local climates. Since the prevailing winds for this latitude are from the west, they arrive in the Atlantic region from the interior of the continent and the moderating influence of the sea is minimized. The average January temperature of -3° at Halifax is about equal to that of

Toronto. However Atlantic ports are able to remain open throughout the year whereas those in Central Canada must close in winter due to the presence of ice in the lower St. Lawrence. Winter temperatures drop considerably inland. Fredericton, less than 100 kilometres from the sea, has an average January temperature of -9°C . In summer warm air from the interior is chilled when it reaches the sea and average temperatures in the high teens help make the coastal areas summer vacationlands for visitors fleeing the sweltering heat experienced over much of the continent. Less appealing are the frequent summer fogs which are also a product of the mixing of cold and warm air. Sea fog is at its worst in July, creating hazards to shipping and often rolling inland to prime tourist areas. Precipitation is well distributed throughout the year, ranging from about 140 centimetres annually along the Atlantic coast of Nova Scotia to about 95 centimetres annually in the interior of New Brunswick. Winters, when there are a large number of cyclonic disturbances, are particularly stormy and heavy snowfalls can occur accompanied by equally sudden thaws.

Figure 25

**SELECTED CLIMATIC DATA FOR TWO STATIONS IN
APPALACHIAN CANADA**

St. John's, Newfoundland

	J	F	M	A	M	J	J	A	S	O	H	D
Temp. ($^{\circ}\text{C}$)	-3	-4	-2	2	6	11	15	16	12	8	4	0
Precip. (cm)	15	16	13	12	10	9	9	10	12	14	16	17

Fredericton, New Brunswick

	J	F	M	A	M	J	J	A	S	O	H	D
Temp. ($^{\circ}\text{C}$)	-9	-9	-3	4	11	16	19	18	14	9	1	-7
Precip. (cm)	10	8	8	9	8	10	9	8	9	10	11	9

Soils in Appalachian Canada tend to be thin and poor. Much of the region consists of granitic upland which provides poor parent material. The best soils have developed in the basins of sedimentary rocks around the Northumberland Strait and in the Annapolis Valley. Patches of glacially deposited sands and clays together with river *terraces*, notably those of the St. John River, provide some of the better agricultural land.

The natural vegetation of mixed forest — mainly coniferous hemlock, red pine and white pine together with deciduous beech, sugar maple and yellow birch — has been much depleted. The magnificent stands of pine, often more than 40 metres high, that were the basis of the nineteenth century timber trade have long since disappeared. The

present forest of rather small trees does however support a considerable forest industry.

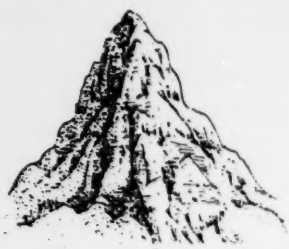
The many fine harbours close by rich fishing grounds contrast strongly with the somewhat limited landbased resources and Atlantic Canada has traditionally looked to the sea for its livelihood. Europe, the homeland of most of the original settlers, is almost as close and was much more easily reached than the colonies of central and western Canada. By the time of Confederation strong local and imperial attachments had already been formed. A long stretch of largely empty land, much of it foreign territory, still separates this region from the rest of Canada.

The Western Cordillera

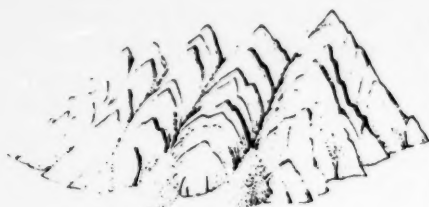
Of the three great Palaeozoic geosynclines the Cordilleran was by far the most stable. While the sediments of its Appalachian-Acadian counterpart were folded and uplifted, eroded away and redeposited several times over, the west remained largely quiescent and massive deposits accumulated on the seafloor. Eventually however, at least three major periods of earth movement raised up the great mountain barrier, 800 kilometres wide, which extends throughout western Canada from the 49th parallel to the Alaskan boundary. There is a wide variety of scenery in the complex jumble of ranges and ridges, plateaux and canyons, and geographers find it convenient to divide the mountains of the Cordillera into western, interior and eastern systems.

The highest peaks are in the Coast Mountains of the western system where the summit of Mount Logan, at 5,950 metres, is the highest point in Canada. These ranges have developed on huge batholiths, granitic intrusions which were formed about 180 million years ago during the Columbian period of mountain building. The structural pattern of the granite seems to be reflected in the nature of the valleys which are characterized by long straight stretches connected by angular bends. Most have been modified and deepened by the great glaciers which poured off the mountain tops during the Ice Age. When the ice melted, these valley flows were drowned to form a spectacular fjord coast. Some rivers, such as the Skeena and Stikine in British Columbia, cut right through the Coast Mountains but steep grades and narrow defiles make passage difficult. For a distance of 700 kilometres the Coast Mountains remain unbreached by road or rail links. The outer ranges of the western system, those of the Vancouver and Queen Charlotte Islands, are very similar in structure and scenery. Between the two, the depression known as the Coastal Trough forms the lowlands on either side of Georgia and Hecate Straits, but this trough is largely submerged in Canada. The scenery of active mountain glaciation, including icefields, jagged mountain peaks, waterfalls and so on, close by the ocean pro-

Figure 26



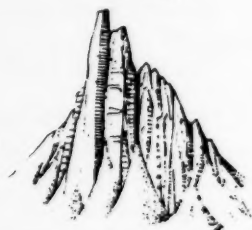
Horn Mountain : Mt. Assiniboine



'Sawtooth' mountains - extended vertical beds :
Sawback Range



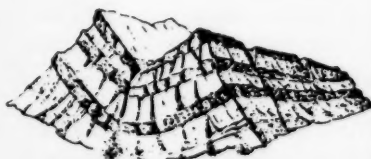
Mountains of complex structure



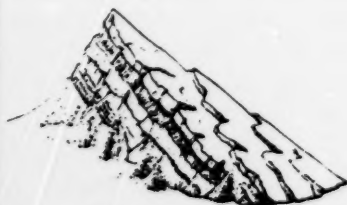
'Dogtooth' mountains - vertical structure :
Amiskwi area, Yoho



Horizontal beds : Mt. Eisenhower



Synclinal mountains :
Mt. Keesee, Jasper National Park



Dipping sediments : Mt. Rundle

Source: J.B. Bird, *The Natural Landscapes of Canada*.

vides an environment that is a vacationer's paradise but a developer's nightmare.

The glaciated mountain scenery of the Rocky Mountain section of the eastern system is equally spectacular. The peaks are somewhat lower — Mount Robson at 3,954 metres and Mount Assiniboine at 3,618 metres. They are formed mainly of limestone which has been strongly folded and faulted during the Laramide period of mountain building, about 65 million years ago. The Rockies are thus some of the world's youngest mountains. The fine scenery is due largely to the effects of erosion acting on different rocks which have been brought together by faulting. Thus resistant beds are etched out and different alignments in horizontal, tilted or vertical positions (see figure 26) have produced a wide variety of scenery. Of particular note are the trenches. These straight valleys have steep, near vertical sides often 600 to 800 metres high and flat bottoms several miles wide. The Rocky Mountain Trench extends for nearly 1,600 kilometres and is drained by six rivers including parts of the Columbia, Fraser and Peace. The Titina and Shaskwak Trenches in the Yukon are smaller. Strong faulting was a major factor in the formation of these features. In the north the eastern fringe of the Cordillera is continued in the Mackenzie and Richardson Ranges but the system is less continuous than further south and contains extensive lowlands, plateaux and plains. Throughout their extent, the mountains of the eastern system are broken by passes and Pine Pass, Yellowhead Pass, Kicking Horse Pass and Crowsnest Pass all carry road and rail links across the high barrier relatively easily.

Sandwiched between the high mountain ridges to the east and west, the interior system is generally classified as a series of intermontane plateaux. These plateaux, while well developed in central and southern British Columbia, disappear north of about 56°N reappearing in less well-developed forms in the extreme north of British Columbia and in the Yukon. Furthermore, the region contains numerous snowcovered peaks of over 3,000 metres and includes mountain ranges which presented a far greater barrier to road and railway builders than did the Rockies. These high peaks are found in the Columbia Mountains and the parallel ranges — Purcell, Selkirk, Monashee and Cariboo — which are structurally related to the Coast Mountains. They have developed on gigantic batholiths intruded into very old sedimentary rocks during the Columbian period of mountain building and were well-established long before the end of the mountain building in the eastern system. Further north the Cassiar-Omineca and Pelly Mountains are similar in structure but generally lower and, though rugged, less spectacular.

The remainder of the interior system consists largely of extensive plateaux developed on a variety of rocks of which basalt flows, extruded about 22 million years ago, dominate. Most of the interior was covered by ice at least once during the great Ice Age when the Cordillera supported its own ice sheet. In this region, where complex mountain and valley structures were already in existence, glacial deposition

assumes distinctive forms. Ice flowed into the valleys and remained there for some time after the uplands were uncovered. The valleys were deepened, sometimes to below sea level as is thought to have happened in the south Okanagan; sediments, sometimes many hundreds of feet thick, were deposited on their floors; kame terraces, such as those found in the Fraser Valley near Lillooet were formed along the valley sides as the ice melted. Meltwater rushed down the slopes of the valleys and covered their floors with sand and gravel. Long narrow lakes occupied many valleys such as the Thompson, Okanagan and Nicola, where waters were ponded back. *Alluvial fans*, deltas and terraces were laid down as the meltwaters drained away. Two such fans have joined across the Okanagan Valley to separate Okanagan and Skaha Lakes and spectacular terraces can be seen on the Thompson near Kamloops and on the Yukon near Carmacks.

Summits seldom exceed 1,200 metres and some of the plateaux, for example in the Nechako-Prince George area, present very subdued relief. In other parts deeply entrenched valleys create areas of striking relief. Valleys in the Yukon plateau are often 600 metres deep and spectacular canyons have been carved in interior British Columbia by the Fraser and Thompson Rivers. These canyons present some of the toughest terrain for transportation. Construction of the Canadian Pacific Railway required the blasting of 27 rock tunnels and the construction of 600 bridges and trestles in the Fraser Canyon alone and parts of the British Columbia section of the Trans Canada Highway cost a million dollars (pre-1962) a mile to build.

The interior plateaux have been the principal areas of volcanic activity in the Cordillera. In addition to the plateau lavas which cover large areas, there are extensive deposits of volcanic ash. Ash transported by wind from Mount Mazama, which erupted about 6,600 years ago, and from Mount St. Helens which last erupted about 3,000 years before its recent activity, covers a very large area of southern British Columbia. The southern Yukon is covered by ash from two eruptions which took place about 1,500 years ago in the Klutian glacier area of Alaska. At least 150 volcanoes thought to have been active about two million years ago have also been identified. They are heavily clustered in fault belts in the southern Coast Mountains, the Stikine Plateau and the Cariboo Mountains. Many low cinder cones plus about 20 high composite volcanoes, such as Mount Edziza in northern British Columbia, have been found. There are no active volcanoes in Canada today but eruptions have taken place as recently as two centuries ago in the Nass Range near Terrace. The dormant volcanoes, Mount Baker and Mount Rainier, within 300 kilometres of the international boundary, have both shown signs of activity in the 1970's, and Mount St. Helens awoke in early 1980. There are occasional earthquakes but they are restricted to the coastal strip and have never been severe in Canada.

Mountain areas where slopes are steep and waters run fast with constant freeze-thaw action denude much more rapidly than do lowland

areas. Water, wind and ice are forever at work seeking to level the relief of the Cordillera and rock slides are common in these areas. Major slides occurred at Frank, Alberta, in 1903 and near Hope, British Columbia, in 1965 and substantial slides and rockfalls regularly block the railways and highways. Thus the Cordillera is the product of repeated and, geologically speaking, recent mountain building with landforms subsequently modified by glaciation, river erosion and mass wastage.

Climate in the Cordillera is strongly influenced by topography with elevation and aspect being important determinants of local weather. Differences due to latitude, distance from the sea and the constant interaction between maritime and continental air masses all combine to create environments varying from luxuriant rain forest to hot desert to tundra.

Very moist and relatively warm polar maritime air dominates the coastal area which is the only part of Canada that enjoys average winter temperatures (see figure 27) above freezing. The heat which has been gathered in during the summer months by the Pacific Ocean is released slowly throughout the winter and carried landward by the prevailing

Figure 27

**SELECTED CLIMATIC DATA FOR TWO STATIONS IN
THE CANADIAN CORDILLERA**

Clayoquot, B.C.

	J	F	M	A	M	J	J	A	S	O	N	D
Temp. (°C)	5	7	7	9	12	13	15	15	14	12	8	6
Precip. (cm)	34	25	29	19	12	9	9	6	14	28	36	42

Kamloops, B.C.

	-6	0	4	9	14	18	21	20	15	9	2	-2
Temp. (°C)	-6	0	4	9	14	18	21	20	15	9	2	-2
Precip. (cm)	3	2	1	1	1	4	2	2	2	1	2	2

westerly winds. Thus Clayoquot, on the west coast of Vancouver Island, has an average temperature of 5° C in January. In summer the tempering effect of the Pacific waters, then cooler than the sunwarmed land, is likewise brought shoreward and Clayoquot's average temperature for July is only 15° C. The range of temperature on the coast is very small: 10° C at Estevan Point, 11° C at Prince Rupert. A February day can occasionally be as warm as one in July. With the westerlies hurling themselves against the Coastal Mountains, precipitation is very heavy in exposed places. The average annual precipitation for Tahsis is 274 centimetres, for Estevan Point 303 centimetres and for Prince Rupert

239 centimetres. There is a marked concentration of precipitation during the winter months when a series of intense low pressure systems is generated in the Aleutians. The average annual snowfall of about 35 centimetres reflects conditions in which very heavy snowfalls can occur but there are many years with no snow at all. Even heavy snowfalls seldom remain on the ground for more than a few days.

Away from the outer coast temperature conditions rapidly become more extreme and precipitation drops sharply. Thus Vancouver on the

Figure 28

	Average January Temperature °C	Average July Temperature °C	Average Annual Precipitation Centimetres
Clayoquot	5	15	264
Vancouver	3	17	123
Kamloops	-6	21	104

Comparative Climatic Data For Selected Stations

inner coast is a little colder in January, a fraction warmer in July and considerably drier than Clayoquot. Kamloops, about 400 kilometres inland, is much more so.

The interior of the Cordillera is more often influenced by Polar Continental and Arctic air masses. Winter temperatures can drop very low, particularly in the north. In Dease Lake, at 58° N, the average temperature for January is -19° C. Summerland at 50° N has an average January temperature of -3° C. Very high summer temperatures are experienced in the southern valleys which are sheltered from the influence of cooling Pacific air. Average July temperatures for Summerland and Penticton are 21° C and 20° C, respectively. Continental air is generally dry and the maritime air which reaches the interior has lost most of its moisture in its passage over the Coast Mountains. Precipitation in the interior Cordillera is generally low, 30 centimetres at Prince George for example, and is fairly evenly distributed all year. Throughout the cordillera the mountainous terrain causes extreme variations in local climate. Within Metropolitan Vancouver, for example, annual precipitation varies from about 100 centimetres at the airport on the Fraser delta to 250 centimetres or more on the upper slopes of the north shore mountains. Residents can often sail or ski within ten miles of each other on the same winter day.

The plentiful moisture and moderate temperatures of the coastal area provide exceptionally favourable conditions for plant growth and this area is famous for its forests. Trees often soar 100 metres upward and diameters of 3 metres are common. Mosses, ferns and vines complete the luxuriant atmosphere. Inland trees gradually become smaller as

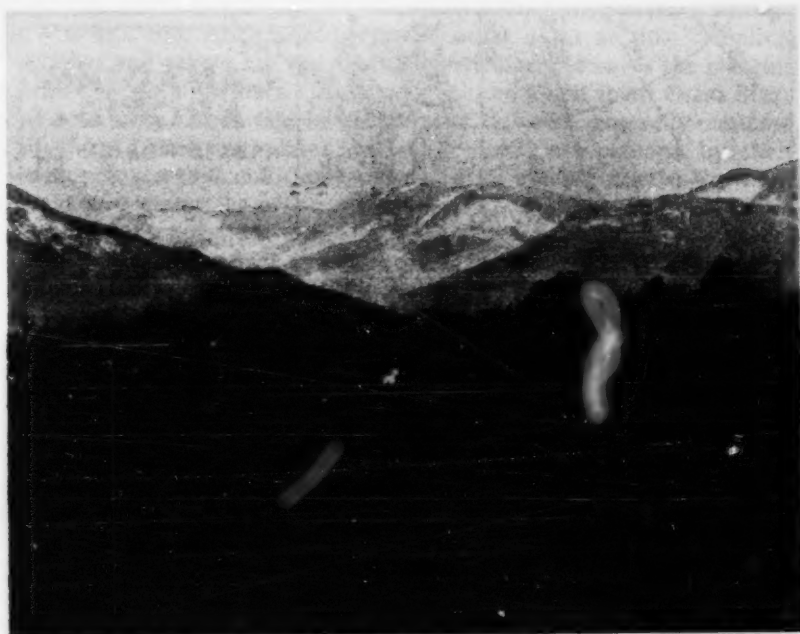


Figure 29: The steep slopes of the Coast Mountains rise behind the flat Fraser River delta near Vancouver.

temperatures become more extreme and precipitation decreases. The interior vegetation ranges from stands of Ponderosa pine amid rough grasses to a true desert of sagebrush, cacti and scrub. To the north and at higher elevations where moisture increases, mixed conifers, many of commercial value, and richer grasses replace the scrub.

The enormous distance coupled with the rugged terrain of the local mountains presented numerous obstacles for the linking of the Cordilleran region with eastern Canada. Indeed, Spanish and British mariners were exploring and mapping the Pacific Coast in the 1770s, two decades before the arrival of Alexander Mackenzie "from Canada by land". The transcontinental rail link, promised as an inducement for British Columbia to enter Confederation, was completed in 1885 and the Trans Canada Highway was opened in 1962. However it is not uncommon for all land transportation links to be blocked by slides or snowfalls at some point during the winter months and communication has always been expensive. It is not surprising that British Columbia and the Yukon often feel isolated from the rest of Canada and have formed close links along their natural communication lines to the south and across the Pacific to the Orient.

This debris was redeposited over the other areas as till. Drumlins, moraines and eskers are widespread, particularly towards the margins of the Shield: in northern Québec and around Great Bear, Great Slave and Athabasca Lakes. Glacial deposits are, however, generally scattered and thin. Lacustrine plains are particularly conspicuous by their absence. It seems that the meltwater escaped easily from the Northern Shield and glacial lakes were small and shortlived. "Barrens" is an appropriate description for much of this landscape.

The borderlands which extend through the Mackenzie Lowlands into Victoria, Banks, Prince of Wales, Somerset, Devon and northwest Baffin Islands, have developed on largely undisturbed platforms of much younger sedimentary rocks. It is assumed that the Arctic archipelago was formerly a continuous land mass that was broken up by a combination of faulting, as is suggested by the very straight sides of many of the channels, and river erosion. It is a region of low relief composed largely of silts rich in ground ice. A fairly continuous spread of small trees covers the southern Mackenzie Lowland but northward the trees thin out to wet tundra in the islands.

The Hudson Bay Lowland is underlain by sedimentary rocks, mainly limestones laid down at the same time as those which form the bedrock of the Interior Plains. This region has, however, been greatly modified by recent marine transgression. It is thought that the sea invaded the area about 7,500 years ago at the end of the Ice Age. At that time Hudson Bay was probably nearly twice its present size. The water has retreated steadily however — contemporary measurements suggest a rate of about 40 centimetres per century — and the limestone beds which slope gently up from beneath the water underlie extensive coastal plains along the south shore of Hudson Bay and on Southampton, Coats and Mansel Islands in the northwest. On the eastern and western shores the limestones have been denuded to expose narrow plains of Shield rocks. Most of the plains are flat and ill-drained. Glacial, lacustrine and marine sediments cover large areas. Pools and bogs, lagoons and tidal flats dot the landscape. However outliers of Shield rocks occasionally outcrop to form slightly higher, better drained sections. The Sutton Hills are a fairly conspicuous feature near Winisk and outcrops along either side of the Churchill River form ridges upon which the town of Churchill and Fort Prince of Wales have been built. A series of major rivers, sometimes deeply entrenched in the recent sediments, cross the southern section of the Hudson Bay Lowlands.

Sharply contrasting are the young fold mountains of the far north. Some of the mountains in this region were formed at the time as the Rockies, others were thrown up at about the same time as the Appalachians. Sand, gravels and silts subsequently eroded from these mountains have been washed down to form a narrow coastal plain. This is the least known part of Canada.

Winters are long and cold in the Arctic. Sometimes Maritime Pacific air penetrates the high barrier of the Cordillera bringing relief to the

interior Yukon and Mackenzie Valley. At other times an incursion of Maritime Polar air from the trough of low pressure over the Labrador Sea will raise temperatures in south Baffin Island and Québec-Labrador. For most of the time, however, (see figure 31) the region is covered by intensely cold air originating in the high pressure centres over northern Siberia, Alaska-Yukon or north Greenland. There are few hours of daylight and the winter period of net radiation loss may last up to seven months. The wind, its force unbroken by trees, intensifies the low temperatures, particularly in the eastern arctic where the pressure gradient often drops steeply towards the Atlantic low. Temperatures of -50° are common.

Winter precipitation usually results from frontal activity and is consequently greatest on the eastern and western fringes where moist maritime air often enters the upper atmosphere. The Québec-Labrador plateau can get 300 centimetres of snow in a winter and amounts in the Mackenzie Lowland and interior Yukon are slightly higher than elsewhere. The extreme dryness of the air keeps overall precipitation very low.

Summer days are very long and when *anticyclones* become established several weeks of warm, sunny weather can produce surprisingly high temperatures. This condition occurs most commonly over the western Arctic where the average temperatures for July reach nearly 15°C almost to the Arctic Ocean. Maximum annual temperatures of 26°C are not uncommon for inland stations. However, for most of Arctic Canada the proximity of the cold sea means that average summer temperatures rarely exceed 6 or 7°C . Thawing usually begins towards the end of April in the Mackenzie Lowlands and the snowcover retreats rapidly northward. Continuous sunshine working on the very low winter snowfall may actually clear parts of the far north before areas to the south are uncovered. By the end of June all but the highest mountain peaks and plateaux are exposed. Only about 5% of the Arctic is covered by permanent ice.

Figure 31
SELECTED CLIMATIC DATA FOR TWO STATIONS IN
ARCTIC CANADA

Arctic Bay, N.W.T.

	J	F	M	A	M	J	J	A	S	O	N	D
Temp. ($^{\circ}\text{C}$)	-29	-33	-27	-20	-7	1	6	5	-1	-10	-21	-27
Precip. (cm)	1	0	1	1	2	2	2	4	2	2	1	1

Whitehorse, Yukon

	J	F	M	A	M	J	J	A	S	O	N	D
Temp. ($^{\circ}\text{C}$)	-18	-14	-8	0	7	13	14	12	8	0	-8	-1
Precip. (cm)	2	1	1	1	1	3	3	4	2	2	2	2

In summer the strong high pressure systems retreat northward and the position of the arctic front at this season approximates that of the treeline. A succession of weak disturbances may pass eastward across the Arctic and bring unstable showery weather. Even so the amount of precipitation is low, generally totalling no more than ten centimetres for June, July, and August. However large amounts of moisture on the surface give the impressions of much wetter conditions, especially in the eastern Arctic where there are often long stretches of damp, cloudy, weather.

Mobility is an important factor of the Arctic terrain in summer. The waterlogged soil is almost liquid and creeps slowly down even the gentlest slopes. This process called solifluction is intensified on steeper gradients and earth flows are common on the silts of the western Arctic. In areas where there is a plentiful supply of fractured rock, freezing moisture percolating into debris leads to the formation of the rock glaciers which occupy many valleys in the high mountains of the Yukon. This process also leads to the development of the boulder streams which choke many valleys in the northeastern Shield.

Microscale soil movements are important in the development of the various kinds of patterned ground which are characteristic of the Arctic. Furrows, usually about 50 centimetres deep, develop above the fingers of ice which accumulate where contraction cracks have been caused by intense cold. The intersection of these furrows produces tundra polygons which are particularly prominent when snow fills the fissures. Sorting, due to the movement of particles of different sizes in a freeze-thaw situation, leads to the formation of circles and polygons with coarser boulders and gravel surrounding the finer sands and clays. The activity of mobile soil in front boils tears at the roots of developing plants and creates patterns where bare circular mud patches are interspersed among the tundra vegetation. Unconsolidated sediments on the shores of shallow thaw lakes are easily moulded into strikingly regular shapes, usually circular, depending on the direction of the summer wind.

Although summer warmth transforms the Arctic by removing the snow cover, the effects seldom penetrate far below the surface. The active layer, which melts each summer, may vary from a few centimetres to a metre or more in depth but ground ice and permafrost are certain to occur not far below the surface. The largest quantities of ground ice usually occur in silts and in Canada are thus most prevalent in the Western Arctic. Massive ground ice with layers sometimes more than 30 metres thick has been discovered in the Mackenzie delta and on Banks, Parry and Sverdrup Islands. When the ice is exposed in cliffs and valley sides it contributes to rapid erosion and slumping. It is thought that stream channel growth is frequently affected by the exposure and melting of ground ice. Smaller accumulations of ice occur in the cores of pingos, the low conical mounds which are characteristic features of the Mackenzie delta, and wedges of ice often define the edges of polygons on the tundra.

Nearly a quarter of Canada is underlain by continuous permafrost. Discontinuous permafrost, which is restricted to northfacing slopes, treeless ridges or poorly drained lowland, covers an additional quarter of the country. There is a marked correlation between the southern limit of permafrost and the treeline. Permafrost creates enormous problems: the frozen layer prevents drainage, hampers waste disposal, limits the spread of plant roots and restricts mining. It creates worse problems if temporarily melted, so structures must be carefully insulated, usually by expensive gravel platforms. Thus oil must be warmed for pumping but gas, which is naturally warm, is sometimes refrigerated because of the problems it causes by melting the permafrost. Pipelines must be heavily insulated, not only to preserve the heat of the contents, but to protect the underlying permafrost. Sometimes the simplest solution to construction problems is to freeze the active layer.

Arctic conditions are generally highly unfavourable to the development of soil because much of the region consists of bare rock. There is little organic matter and decomposition in low temperatures is a very slow process. Drainage is usually poor and such soil as develops is very mobile. The best soils are found in the southern parts where summers are warmer, particularly in the Mackenzie Lowland which is the most favourable area both in climate and terrain.

Although the harsh environment imposes severe limitations on plant growth the Arctic supports a wide variety of plants. Even the harshest environment, the high mountains and the bare rock plains, supports patches of crustaceous lichen and tiny but very colourful flowering plants cover the desert areas for brief periods in summer. Most of the Arctic supports a fairly continuous vegetation cover. The drier areas, those developed on outwash sands, river terraces and patches of sandy till, support lichen and mosses which are interspersed in warmer parts by numerous berry plants. Wet tundra with a dense cover of grasses and sedges develops on fine grained soils in which much ice is preserved. In the south of the tundra zone protected areas, such as the sheltered valleys on the south side of Coronation Gulf and any southfacing slopes, can support willows and alders. Trees are often less than a metre high but can occasionally reach three metres and in favoured locations may form patches of dense woodland. Scattered spruce appear in the vicinity of the treeline and a band of forest-tundra vegetation 50-150 kilometres wide extends from the Mackenzie delta to the Labrador coast.

The northern environment is particularly fragile. Organic matter does not break down easily and discarded waste remains an unsightly menace almost indefinitely. Bulldozer tracks are clearly visible twenty-five years after they are made and erosion, once started, rapidly gallops out of control. Permafrost, once melted, may cause all kinds of problems through subsequent ice formation. Flora and fauna grow slowly and depleted stocks are not easily renewed. If disrupted the land is slow to recover.

Figure 32

FRIDAY: Cloudy, showers.

SYNOPSIS: A series of Pacific disturbances continues to move across the province bringing rapid changes from steady rain to showers, with continual cloudy and windy conditions.

REGIONAL FORECASTS

Greater Vancouver, Lower Mainland, East Vancouver Island — Cloudy with showers. Lows near 8. Highs near 12.

Greater Victoria — Mainly cloudy with a few showers. Lows near 8. Highs near 11.

Howe Sound, Whistler, Sunshine Coast — Cloudy with showers. Lows near 8. Highs near 12.

North and West Vancouver Island — Cloudy with a few showers. Lows near 8. Highs near 11.

Northern Mainland, Queen Charlotte Islands — Cloudy with showers. Lows 8 to 10. Highs near 12.

Thompson, Okanagan — Cloudy with isolated showers. Lows near 8. Highs 11 to 13.

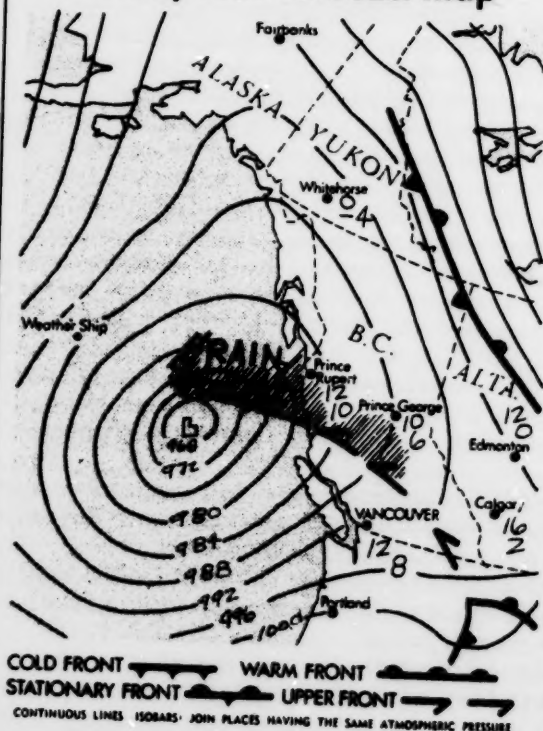
Columbia, Kootenay — Cloudy with showers. Lows 3 to 6. Highs 11 to 13.

Chilvestin, Carleton, Central Interior — Cloudy with a few showers. Lows near 8. Highs near 10.

TEMPERATURES

	Max.	Min.	Prc.
St. John's	12	7	35.2
Halifax	12	-1	10.8

Friday a.m. forecast map



Although this region extends over nearly one-third of the total area of Canada few people have firsthand knowledge of it. Of those few most have spent only a short time there, researching, prospecting, or maintaining military installations. However increasing population pressure, diminishing resources and changing technology make it likely that the Arctic lands will become increasingly important.

The Physical Structure of Canada in relation to the total Canadian Environment

This chapter makes it evident that most of the Canadian environment, even after more than three centuries of European settlement, remains comparatively little changed by man. Moreover the man-made landscape has, not surprisingly, been considerably affected by the physical environment in which it is set.

It is no coincidence that physical criteria have been basic to delineating the regional character of Canada. Many, possibly most Canadians, when they think in terms of a total national environment, think of the physical attributes of regions defined in terms of those used in this chapter. Hodgetts in *What Culture? What Heritage?* reported that "a feeling for the land" was the most positive identification with their country made by young Canadians.⁸ For them, in other words, the physical structure of Canada was the essential Canada.

It was these characteristics of the Canadian environment that caused a French geographer, Réclus, more than half a century ago to write that Canada had "a fantastic frontier". In his words, "The vast stretch of lands occupying all the northern section of North America and politically defined as the 'Dominion of Canada' constitutes no distinct geographical unit."⁹ As this chapter suggests, there are other ways of looking at Canada in which it can be perceived as a distinct northern entity. In the words of R. Cole Harris, another contemporary Canadian geographer:

Both views of Canada capture(d) elements of its reality. Canadians have had to deal with an extremely limited northern land. Major cities — St. John's, Halifax, Québec, Vancouver — have rock-bound, ice-scoured horizons as, at another scale, do all the larger regions of Canadian life. Canadians are tied to wilderness as are few other modern people.

Harris goes on to argue that even though more than a century of Confederation has produced "a great deal of pro-Canadian sentiment",

⁸ A.B. Hodgetts, *What Culture? What Heritage?* Ontario Institute for Studies in Education, Toronto, 1968.

⁹ Elisée Reclus, *Universal Geography*, as cited by C. Harris in "Within the Fantastic Frontier". *The Canadian Geographer*, Vol. XIII, No. 3, 1979.

there exists also "a profound Canadian disunity . . . anchored in the country's geographical spine."

The fundamental line on the Canadian land is the northern edge of the Canadian Shield — our principal boundary between the desert and the sown. Its location meant that in an age when most people depend on agriculture there could not be a continuous, expansive, Canadian experience with the land. Settlement proceeded in patches. One patch would fill up, then people would emigrate, south more often than west because the next Canadian patch was inaccessible. This process imparted a striking discontinuity . . . The country did not expand westward from an Atlantic beginning; it was settled, patch by patch from Europe. This pattern of settlement has differentiated the Canadian experience from the American.

The "patches" referred to by Harris correspond to a high degree to the physical regions discussed in this chapter. Regions as a geographical concept imply some degree of internal similarity based on particular criteria. Each of the six regions that make up the physical structure of Canada as it is defined here, clearly accord with such a concept.

The six regions which have been identified are the end result of having compared and analyzed physical geographical patterns throughout the country and its parts. That end result is a form of pan-Canadian understanding of particular value in appreciating Canadian realities. The physical structure of Canada embodies a major Canadian reality and can be related to what Hodgetts and Gallagher call the "five basic features of Canadian society".

An understanding of the interrelationships among these features per se and between the features and the physical structure, as well as the consequences of such interrelationships for Canadian society, is a prerequisite for pan-Canadian understanding. The notion that "Canada is a northern, vast and regionally divided country" is clearly related to its physical structure. Its "broad natural resource base comprised of both renewable and non-renewable resources" is largely a function (or consequence) of its physical structure. Canada as "an industrial, technological and urbanized society" is considerably dependent on the nature of its resource base. The nation's physical structure has both positive and negative implications for this feature. Most of our urbanized population lives in a narrow southern fringe section of that critical southern Canadian Shield boundary to which Harris refers. The Shield and its climate considerably affect life in that southern fringe. Harris' concept of "patches of settlement" as a function of the physical nature (and diversity) of Canada assists an understanding of the basic feature of cultural diversity and multi-ethnicity. Finally, plains and oceans alike have helped to guarantee that Canada "is exposed to a multitude of external economic, political, and cultural influences".

From the foregoing it is evident that the physical structure of Canada has many consequences for Canadian society. A number of these have been indicated. These consequences include both problems and oppor-

tunities. The physical characteristics of the country have an impact on the ways of living of people in different parts of Canada. Where Canadians live influences how they live and think and what they value most highly. Each major physical region has a "character" of its own which distinguishes it from other regions. It is out of this character, when linked with the social, cultural and other characteristics of a given region, that "regional consciousness" develops. This consciousness tells inhabitants of the Canadian Shield, for example, that their region differs significantly from other regions of Canada. At the same time, it may cause them to view the totality of Canada differently from the way it is viewed in other regions. Canadians are also aware that they share similarities (a climate of extremes over most of the country, for example) no less than they are aware that they are divided by differences.

Although in one sense Canada is one, in a physical sense Canada is at least six quite different units. Many of the serious economic disparities which exist between the various regions of Canada are related to environmental inequalities.

Differences in income show considerable correlation with the nature of the activities which are possible in a particular milieu. Thus areas which must rely heavily on trapping or fishing — activities generating significantly lower incomes than do mining or finance — are likely to be economically disadvantaged. Inequalities in transportation, particularly important in such a large country, are inevitable. Some areas are fortunate to have easy access to major markets, raw materials, energy or cheap water transport. Others are challenged by vast distances, difficult terrain or local climatic hazards.

The disparities continue despite economic fluctuations such as the soaring price of oil which has brought prosperity to Alberta in recent years, and notwithstanding decades of determined efforts to level the balance by means of tax benefits, subsidies and equalization payments. Where one lives in Canada influences one's educational opportunities, one's job prospects, even one's life expectancy.

Most Canadians feel at least as strongly identified with their particular region as with their country. Yet in defiance of geographic logic, the unity that is Canada emerged and has maintained itself for more than a hundred years. In the time to come understanding of the total environment can only assist to assure the best possible future for all Canadians, indeed for humankind.

GLOSSARY

Alluvial Fan: The deposit of sediment laid down by a swift-flowing stream as it enters a plain or open valley, so called because of its shape.

Anticyclone: A region of high pressure which shows at least one closed isobar. In the northern hemisphere the general wind circulations is clockwise around the anticyclone. Near the centre the winds are usually light, often calm, but they increase in strength towards the edges as outblowing air seeks to level the pressure gradient with adjacent areas of lower pressure.

Badland: An elevated, arid region where, because normal precipitation is insufficient to support an adequate protective vegetation cover, occasional heavy rains have carved deep gullies. Tall columns of more resistant rocks are often left standing above the surrounding land.

Batholith or Bathylith: A dome-shaped mass of igneous rock, often granite, formed by the intrusion of magma. Batholiths often extend over hundreds of square miles.

Bedrock: The solid rock beneath the soil, subsoil and other loose rock material of the earth's surface. Bedrock may be exposed at the surface or may be buried hundreds of feet below.

Chernozem or Black Earth: Black or dark brown soil containing a large amount of humus. The soil is fine and very rich in plant foods. It is associated with a natural cover of grass.

Denudation: The wearing away of the land by such natural agencies as water, wind sun, ice. Also referred to as erosion.

Differential Erosion: The wearing away of rocks at differing rates due to their different degrees of resistance.

Dip Slope: The gentle slope of a cuesta.

Drift: Any deposit which has been transported. Usually applied to material transported by a glacier (glacial drift).

Drumlin: An elongated asymmetrical hill or ridge of glacial drift. The long axis lies parallel to the direction of flow of the ice. The steeper end faces the direction from which the ice came. They occur in large groups. The exact manner of their formation is uncertain.

Entrenched Valley: One in which vertical erosion has predominated so that valley sides are cut steeply into the plateau surface.

Escarpment: See *Scarp*.

Esker: A long, narrow ridge of sand and gravel which was deposited on the bed of a stream flowing beneath a glacier and left behind when the ice melted.

Estuarine Clays: Sediments deposited in river estuaries.

Extrusion: The pouring out of molten material or magma on the earth's surface, as with lava flows.

Fault: A fracture in the earth's crust where rock strata on the two sides do not match.

Fault-Guided Scarp: A scarp situated where a fault has taken place, being due to the relative downward movement of the strata on the lower side.

Fold: A bend in the rock strata caused by movements in the earth's crust.

Front: The zone of meeting of two air masses.

Frontal Precipitation: Precipitation caused by the mixing of different air masses in the frontal zone.

Geosyncline: A very large depression in the earth's crust which gradually fills with sediment as the floor subsides.

Glacially Overdeepened Valleys: Valleys where the passage of glaciers has resulted in a U-shaped profile, an uneven valley floor and straightened course, often with truncated spurs and hanging valleys.

Growing Season: That part of the year when climatic conditions make it possible for vegetation to grow.

Hanging Valley: A tributary valley which enters the main valley high above the latter so that a waterfall is formed.

Head Erosion: The action by which a river lengthens its valley upstream by cutting back.

Igneous Rock: Rocks which have solidified from molten magma.

Innuitian Province: The folded belt of the far north.

Intrusion: The accumulation of molten material in spaces beneath the earth's surface.

Kame: A mound of gravel and sand formed by the deposition of sediment from a stream as it ran beneath a glacier.

Lacustrine: Relating to a lake. Lacustrine plain — one formed from sediments deposited on the floor of a former lake.

Loess: Deposits of fine silt or dust transported by wind.

Magma: Molten material beneath the earth's crust.

Monadnock: An isolated hill which stands above the surrounding country because its rock has been more resistant to erosion than that which surrounds it.

Moraine: The debris or fragments of rock material at the edge of glacier ice. Lateral, medial, ground and terminal moraines are formed where such material appears at the sides, meeting point, undersurface and outermost edge respectively.

Orographic Precipitation: Precipitation which is caused when the presence of mountains forces moisture-laden air to rise and be cooled.

Outcrop: Rock strata which are exposed at the earth's surface.

Outlier: A mass of comparatively new rocks surrounded by older rocks having been separated, usually by erosion, from the main mass to which it belonged.

Outwash Plain: The alluvial plain formed by the deposition of material carried by rivers originating in mountain areas or from meeting ice-sheets.

Palaeozoic: The Ancient Life Era from about 600 million to about 200 million years ago.

Peneplain: Almost a plain. Its formation is often due to a long period of levelling by erosion. An uplifted peneplain often becomes a plateau. Summits which reach a uniform height and may be somewhat flattened are often the remnant of a peneplain surface.

Permafrost: Ground that is permanently frozen.

Physiological Temperature: Temperature readings which take into account such factors as wind-chill and humidity which affect the "feel" of the official recorded temperatures.

Platform Rocks: Fairly flat-lying sedimentary rocks.

Podzol: Soils developed where precipitation is moderate and evaporation limited. The upper layers are leached and very pale in colour while a darker layer appears below. Podzols develop mainly under a vegetation of coniferous forest.

Precambrian: All of geological time preceding the appearance of life at the beginning of the Palaeozoic era about 600 million years ago.

River Capture, Beheading or Piracy: Takes place when one river system cuts back very vigorously and ultimately diverts the waters of another system to its own channels.

Scarp: An inland cliff or rock, usually formed where resistant overlying rock outcrops. Often the steep face of cuesta, sometimes the result of differential erosion along a fault.

Stevenson Screen: The standard shelter where thermometers at meteorological stations are protected from local influences such as direct sunlight and wind.

Stoss and Lee Relief: Asymmetrical profiles found where ice sheets have passed over hill and mountain areas. The slopes facing the sources of the ice are gently contoured while those on the lee side are steep and rugged.

Subsequent Stream: A tributary of a consequent river. Subsequent rivers usually flow over unresistant rocks and carve broad valleys.

Terraces: Platforms of alluvial material left alongside rivers or lakes which later moved to a lower level.

Till and Boulder Clay: Rocks, sand, gravel and finely ground rock flow dragged along in the lower part of glacier ice. Unstratified clay with many stones.

Truncated Spur: A spur which has been shaved off by the passage of glacier ice.

Unconformity: The meeting place of rock strata which have not been laid evenly one over the other. Unconformity usually indicates a radical change in conditions such as a long period of erosion or a time of earth movement.

Vulcanism: The various processes by which magma rises into the earth's crust or is ejected onto its surface.

Watershed or River Basin: The area drained by a river and its tributaries.

SUGGESTED READING

I Print Material

A. General:

Most of the standard texts on Canada include several chapters on the physical environment. Several also provide more detailed information for each of their selected regions. It should be noted that few of these texts have been metricated.

Hamelin, L.E. *Canada: A Geographical Perspective*. John Wiley & Sons, Toronto, 1973, English Translation by Margaret C. Storrie and C. Ian Jackson. Two of Hamelin's five themes — Temperature Range and Northern Character, and Character and Regional Division of the Landscape — are of particular value to the student of the Canadian environment. This author deals with the whole of Canada rather than concentrating on the main areas of human settlement. The book is of particular interest as a French-Canadian viewpoint. Metricated.

Hare, F. Kenneth and Morley, Thomas. *Climate Canada*. John Wiley & Sons, Toronto, 1979. 2nd edition.

Innis, D.Q. *Canada: A Geographic Study*. McGraw-Hill, Toronto, 1966. Includes two colour reproductions of 1:50,000 scale topographic maps with detailed interpretation for each region. Questions and problems.

Kreuger, R.R. and Corder, R.G. *Canada: A New Geography*. Holt, Rinehart and Winston, Toronto, revised edition, 1974. Colour photographs. Exercises and projects. Local study. Metricated.

McBoyle, Geoffrey and Edward Sommerville. *Canada's Natural Environment: Essays in Applied Geography*. Methuen, Toronto, 1976.

Putnam, D.F. and Kerr, D.P. *A Regional Geography of Canada*. Dent Canada, Toronto, 1956. General and regional material.

Putnam, D.F. and Putnam R.G. *Canada: A Regional Analysis*. Dent Canada, Toronto, 1970. More than usually full treatment of climate, particularly significance of climate. Good bibliography.

Robinson, J.F. *Regional Geography of Canada*. Statistics Canada, Year Book Division, Ottawa, 1972. A concise account of the physical basis of the six major regions of Canada. Excellent coloured illustrations.

Warkentin, J. (ed.) *Canada: A Geographic Interpretation*. Methuen, Toronto, 1968. A collection of essays prepared under the auspices of the Canadian Association of Geographers.

Canadian Government Publications, *The Climate of Canada*. Information Canada, Ottawa, 1973.

Physiographic Subdivisions of Canada. Dept. of Energy, Mines and Resources, Ottawa, 1970.

Canada Year Book and Handbook of Canada. Statistics Canada, Ottawa. Published annually.

B. Regional and Specific:

Beaty, C.B. *The Landscape of Southern Alberta: A Regional Geomorphology*. University of Lethbridge Production Services, 1975. Comprehensive but simple treatment of landforms of Cordillera and Plains. Annotated photographs.

Bird, J.B. *The Natural Landscapes of Canada: A Study in Regional Earth Science*, John Wiley & Sons, Toronto, 1972. Comprehensive, detailed, illustrated, clear.

Bird, J.B. *The Physiography of Arctic Canada*. Johns Hopkins University Press, Baltimore, 1967. Very detailed but clear.

Brack, D.M. *Living With Snow*. Canadian Geographical Journal, April, 1973. Explores the Canadian response to the problems of snow. Illustrated.

Brown, R.J.E. *The Permafrost Map of Canada*. National Research Council, Division of Building Research, 1968. Well illustrated material on the nature and problems of permafrost.

Chapman, L.J. and Putnam, D.F. *The Physiography of Southern Ontario*. University of Toronto Press, 1966. Very detailed. Of particular value for local study.

Gunn, A. *Landforms and Settlement*. Smith Lithograph Company, 1250 Vulcan Way, Richmond, B.C. Teaching material. A collection of large scale topographic maps of various parts of British Columbia integrated with photographs.

Taylor, A. *Our Polar Islands — The Queen Elizabeths*. Canadian Geographical Journal, June, 1956. Reprinted by Dept. of Northern Affairs and Natural Resources, Ottawa. Excellent photographs with good explanatory text.

C. Atlases

Atlas of Canada. Dept. of Mines and Technical Surveys Geographical Branch, Ottawa, 1957. Numerous maps, all aspects of physical environment. Colour.

National Atlas of Canada. MacMillan of Canada in association with Dept. of Energy, Mines and Resources and Information Canada, Ottawa, 1974. Coloured maps and diagrams plus some explanatory text.

Atlas of Climatic Maps. Dept. of Transport, Meteorological Branch, Ottawa, 1967-70. B & W maps, all types climatic data.

Farley, A.L. *Atlas of British Columbia.* University of British Columbia Press, Vancouver, 1979. Colour. Maps, photographs and extensive explanatory material. Metricated.

Richards, J.H. and Fung, K.I. *Atlas of Saskatchewan.* University of Saskatchewan, Saskatoon, 1969. Colour. Maps, photographs and text.

Weir, T. *Economic Atlas of Manitoba.* Dept. of Industry and Commerce, Winnipeg, Manitoba. Colour. Includes large maps of resource base plus descriptive material.

Weir, T. and Matthews, G. *Atlas of the Prairie Provinces.* Oxford University Press, Toronto, 1971. Colour, Maps only.

Wonders, W.C. et al. *Atlas of Manitoba.* University of Alberta Press, Edmonton, 1969. Colour maps only.

D. Topographic Maps

Large scale 1:25,000 — 1:1,000,000 obtainable from:

Canada Map Office Department of Energy, Mines and
Resources
615 Booth Street
Ottawa, Ontario
K1A 0E9

Order maps by name and number. Prepaid at \$1.50 per sheet (full size, full colour) plus 50¢ for handling.

II **Audiovisual**

A. Films:

Snow. 12 min., B & W. Physical aspects of snow. National Film Board of Canada.

Glaciation. 11 min. Colour. The life and activity of glaciers in the Canadian Arctic and Cordillera. National Film Board of Canada.

Tides of Fundy. 14 min., Colour. A Study of the Fundy Tides and how they affect life in the region. Province of Nova Scotia and Crawley Films Ltd.

Temples of Time. 42 min., Colour. The story of mountains in Garibaldi Park, B.C. Emphasizes conservation. National Film Board of Canada.

Northwest Passage. 26 min., Colour. The 1970 Voyage of the Supertanker Manhattan. National Film Board of Canada.

The Living Arctic. Colour. Flora and Fauna: emphasis on problems of environmental change. Marlin Films Ltd. (C.B.C.)

Canada: Landform Regions. 15 min., Colour. An overview of contrasting landscapes. National Film Board of Canada.

The Climates of North America. 16 min., Colour. What climate is and how it shapes vegetation and life. National Film Board of Canada.

The Canadian Shield: Saguenay Region. 11 mins. Colour. National Film Board of Canada.

The Face of the Arctic. 12 min. Colour. The geological evolution of the Arctic. National Film Board of Canada.

The Rise and Fall of the Great Lakes. 16 min. Colour. Recent geological history and current ecological problems. National Film Board of Canada.

B. Filmstrips

Geography of Canada. Toronto: Encyclopaedia Britannica Publications Ltd., A Series of filmstrips in colour. Manual provided. Physical Geography — photographs of various types of Canadian terrain. Six regional filmstrips — Atlantic Provinces, Lowlands of Southern Québec, Southern Ontario, Canadian Shield, Prairie Region, Western Mountain Region — each includes excellent pictures of physical environment.

Teachers and students of the Canadian environment are particularly fortunate in that primary source materials are available free of charge to everyone at all times. Indeed the environment is inescapable, affecting as it does the detailed arrangements of our daily lives. Yet many Canadians remain woefully ignorant of the surroundings in which they live. They do not know the 'what', much less the 'why', of their local landscapes and climates.

Field work should be the first priority of every teacher and student of the environment. At the outset it should be noted that field work does not necessarily require an expensive hired vehicle or other special equipment. It need not create havoc and disruption in class schedules or produce mobs of undisciplined students high on being let out for the day. It can be done in class time in the immediate environs of the school, as homework assignments or in organized programmes after school hours (see Exercises A and B). Using buses, bicycles and hiking boots or shoes has positive value in that keener observation is promoted. However the scope and range of field studies is greatly extended when special transportation scheduling can be arranged.

Exercise A

Making observations in the school yard

- A. (1) Take note of the site of the school. Is it on a hillside? ridge? valley floor? plateau?
- (2) Walk around the building and observe carefully the differences between the north and south facing sides.
- (3) Examine any rock outcrops.
- (4) Take a soil sample being sure to get below the surface layer. Are there distinct horizons visible? Is the soil generally sandy and friable or heavy and clayey? Consult with the chemistry department on the chemical content of the soil.
- (5) Set up a weather station. Obtain maximum and minimum, wet and dry thermometers if possible. Otherwise use a simple thermometer and read it at the same times each day.
- (6) Make observations at different times of the year. Compare conditions on Remembrance Day and Victoria Day.
- (7) Observe cloud formations and relate them to the daily weather map.
- (8) Where appropriate, take notes of natural vegetation, prominent local physical features and any other significant factors.
- B. Relate your observations to the available source materials: geological, soil and topographic maps, weather statistics.

Exercise B

Doing field work in the local area

- A. (1) Visit a viewpoint such as an overlook, a tall building or similar vantage point. Study the form of the land. Is it generally flat? hilly? mountainous? What are the most prominent features? river valleys? arms of the sea? rocky patches? Do all the high points seem to rise to about the same level? Does the country look much the same in all directions or can you see more than one type of landscape? If so, note the different characteristics and locations of each.
- (2) Visit a rock exposure on a building site, quarry, cliffside or bank. (Remember that, geologically, sand gravel and clay are just as much rocks as granite and marble.) Observe the form of the rock. Is there any indication that it has been folded or faulted? Are there any unconformities? Note the characteristics of landscape developed on this kind of rock.

- (3) If possible find a place where the natural vegetation can be seen close at hand. Observe the species carefully.

- B. Relate your observations to other source materials. Create as complete a picture of the area as possible and attempt to organize the material into a synthesis.

In the schoolyard, atop a mountain lookout, aside a quarry face or beneath the forest canopy the object is the same; to train the student to examine at firsthand the various aspects of the environment, both macro and micro, and then interpret, correlate and compare the findings.

The field is the milieu of geographers and geologists much as the laboratory is for natural scientists and the archives for historians. The field trip is designed for gathering data and solving problems not, as it sometimes seems, as a sightseeing expedition or guided tour. However students, particularly those inexperienced in field techniques, need some props and guidelines. In the early days it is essential that the teacher be thoroughly familiar with the ground to be covered. Work will proceed much more efficiently and smoothly if suitable viewpoints, rock exposures and so on have been located in advance and the necessary arrangements made with friendly farmers and industrial personnel. Teachers must determine the general focus of the study and must prepare specific materials, such as maps, questionnaires and instructions, ahead of time. It is usually wise to provide at least two copies since print material becomes wet, torn and generally dog-eared in the field.

Information about the shape of the land, the amount and distribution of surface water, the natural vegetation, soil, land use, distribution and character of settlement is easily gathered. Students will quickly learn to evaluate the significance of the various elements which have contributed to a particular environment. Simple questions such as, "What do you notice about the shape of the mountains? (valley? lakes? coastline?), "What is the major form of land use?" and "Why is this a good site for a textile mill?" can be quickly superseded by "Comment on the topography" or "Compare the north and south facing slopes". It is a short step to "What evidence is there that this area was once covered by ice?" or "Suggest why the town grew up in this location?"

Having learned how to use field techniques to get the "feel" of the local environment students can be assigned tasks to be carried out unsupervised. Classes can be divided and sent to gather data in contrasting areas. Teachers and students can work together in unfamiliar territory accessible on weekend trips, by exchange visits or through recreational and other interest groups in the school or community. Natural history, outdoor hiking, conservation and archaeology clubs are usually cooperative. After a few sessions of guided field activity students at any level should be encouraged, if not required, to prepare an individual field study. Initial efforts may be somewhat crude but, given time, it

should be possible for students to make a thorough and complete analysis of their environment.

Field study is inevitably confined in both space and time. In order to expand their knowledge to encompass what lies beyond the mountain and below the lake, or even what the same locale is like on another day or in another season, students must learn to handle a variety of other source materials. They must be able to read maps, pictures, statistics, descriptive materials and anything else that will "train future citizens to imagine accurately the conditions of the great world stage."*

Pictures are obviously the closest approximation to real field experience and are the most readily available of all visual aids. Wall pictures, filmstrips, slide collections, movies and videotapes are obtainable, often free of charge, from various educational, industrial, commercial and even personal sources. Magazines and posters, tourist literature, advertisements and books of all kinds are accessible to virtually everyone. Whatever the source, the function is the same. The picture simulates conditions in the field and must be read and analyzed in the same way. All too often pictures are regarded as the sugarcoating on the pill or as window dressing to brighten up the text when in fact they are the very basis of vicarious environmental study. Careful scrutiny of selected photographs yields a great deal of information. Aided at first by well phrased questions students can quickly learn to analyze picture material (see Exercise C).

Exercise C

Analyzing a picture

Look carefully at the landscape portrayed in Figure 21.

- (1) Look first at the shape of the land.
 - (a) What adjectives best describe most of the area shown? (level, flat)
 - (b) What is the most prominent physical feature of this area? (river valley)
 - (c) Describe this feature carefully. (Cut deeply into plain, sides are steep and severely eroded, floor is narrow.)
- (2) Now look at how the land is used.
 - (a) What is most of the area used for? (Almost all cultivated, field crops.)
 - (b) What can you tell about the farms? (Very large, huge, unfenced fields, highly mechanized, no stock.)

*James Fairgrieve, *Geography in School*. University of London, Press, London, 1930, page 18.

- (c) What do these findings suggest about the bedrock and soils of this area? (Easily worked, fertile, probable sedimentary material laid down by water, wind or ice.)
- (3) What does the photograph indicate about transportation on the Plains? (Long, straight roads, easily built, crossing the entrenched valleys is the main problem.)
- (4) What does the photograph suggest about the settlement in this area? (Rural and agricultural)

More advanced students can handle much more generalized questions such as "What fundamental physical characteristics of the Canadian Shield are illustrated by the photograph in Figure 5?" Half a dozen such pictures is about the maximum number which can be effectively handled in the average class period.

Aerial photographs are particularly valuable for revealing patterns which are not easily recognizable at ground level. The distinctive designs of the prairie checkerboard, the strip farms of the Red River Valley and the radial settlements in Québec, barely perceptible in the field, are clearly visible from above. Stereo viewers enhance the quality of air photo study but are not essential.

Still pictures are best suited for most studies but movies are particularly effective in transmitting some concepts, for example, the length of a lake freighter as it passes beneath a bridge, the height of a Douglas Fir as the camera pans up its trunk, the effort of toiling in 100% humidity, or the erosive power of the spring freshet. Educational movies such as the National Film Board's *Canada: Landform Regions* and *The Climates of North America* provide a useful overview, particularly as an introduction or for a quick wrap up. Commercial movies and television programmes such as *The Drylanders*, *Who Has Seen the Wind?* and *The National Dream* help create regional atmosphere and assist in integrating environmental studies with the broader curriculum.

Painters too should not be overlooked in their interpretation of the Canadian environment. The works of Emily Carr, Tom Thomson A.Y. Jackson, Clarence Gagnon, Alex Colville and many others provide an interesting basis for discussion of the environments they seek to portray. It is noteworthy that a very high proportion of Canadian painting is concerned with capturing on canvas the quality of the environment.

Because of their immediate visual impact and their utility in imparting the feeling and atmosphere of a particular place pictures of various kinds are usually a good jumping off point for environmental study. It must not be forgotten however, that pictures, albeit carefully selected as representative, portray at most a few square miles of the region under study. Detailed picture study must therefore be carefully integrated into a more generalized view. An obvious progression following the analysis of a photo or picture is to the topographic map of a similar area and then to

the physiographic map to find out the location and extent in Canada of this type of terrain.

Less evocative of the real thing but more scientifically accurate are the large scale topographic maps on scales of 1:25,000 to 1:1,000,000 which are available in most large centres or directly from the Canada Map Office, Department of Energy, Mines and Resources, 615 Booth Street, Ottawa, Ontario, K1A 0E9, at a cost of \$1.50 per sheet prepaid. Extracts are also available in some textbooks or in some volumes on mapreading and interpretation. A selection of those maps is one of the best investments a teacher of environmental studies can make.

Topographic maps provide detailed information about landforms, surface water, vegetation and cultural features. The largest scale maps are sufficiently detailed for every student to pick out his/her own home. These provide an excellent bridge between picture material, particularly aerial photographs, and smaller scale maps. It is to be hoped that students will have had some experience in making maps, beginning with the classroom plan, and will have received some instruction as to how maps are produced, the use of conventional symbols and so on. Furthermore, topographic maps should be integrated into field work so that learn the essential relationships between what they see on the map and what they see on the ground. Eventually, having learned to read information off the maps and to correlate that information with real conditions, they should be able to form an accurate image of terrain for which only the maps are available.

Map analysis is the process by which the various components such as contours, surface water, vegetation and so on are traced off separately and can then be superimposed for analyzing patterns and relationships. While time consuming it is a very valuable exercise, particularly for highlighting landforms which are frequently overshadowed by other data.

Exercise D

Studying a large scale map

Make three tracings from the map in Figure 14.

- (1) Trace only the contours. Then use this copy to record any other information about the actual form of the land, quarries, mines and prominent physical features such as peaks, gorges and canyons.
- (2) Trace off all the surface water, again marking in any special features such as falls, rapids and marshes.
- (3) Record everything the map tells you about land use. First trace off the woodland (if you have a coloured map) and note any information about farms or factories.*

* The analysis can be extended to explore settlement patterns, transportation links and so on.

Now use your maps to answer the following questions:

- (1) What adjectives best describe the land surface of the greater part of the area? (Flat, level, lowlying.)
- (2) What is the most prominent physical feature? (Mont St. Hilaire)

Note everything the maps tell you about it. (Rises very steeply for about 1,000 feet** above the plain; has total area of about four square miles; is actually squarish or circular in shape although it always appears as long and low on the horizon; has three distinct summits each rising to about 1,250 feet plus several minor knolls; slopes are deeply dissected; heavily wooded; a squarish lake about one third of a square mile at 600 feet; many orchards at the base of the mountain a little above the general level of the plain but before the slope becomes steep.)

- (3) What does the map tell you about the surface water of the Montreal Plain? (Many very small streams; the slopes of both the longitudinal (the gradient from the headwaters to the sea) and of the transverse (the shape of the valley as viewed at right angles to the flow) profiles are barely perceptible; many drainage ditches suggest a waterlogged area, clay soil?)

The student thus amasses a great quantity of information regarding the physical character of the Montreal Plain. These data can be related to that provided by smaller scale maps showing the number and location of the various Monteregian Hills and the extent of the Plain. They should be integrated with picture and other print material for the region. It is hoped that the student will gain both a real appreciation of the nature and character of this region and some understanding of its space relationships.

Weather maps are to climate what topographic maps are to physiography: they attempt to provide an instantaneous picture of the weather in a specific area at a given time.

It is hoped that high school students will have received some training concerning the compilation and interpretation of meteorological data, having begun by sticking happy face suns and open or closed umbrellas on the kindergarten weather calendar and advanced through more accurate and scientific methods of recording information to some understanding of such concepts as those of air mass and the averaging of various meteorological statistics.

The daily weather map which is available to the schools from the Atmospheric Environment Service records observations regarding wind speed and direction, air temperature and dew point, weather, (such as snow, rain, fog), sky condition, type of clouds present, sea level pressure and the pressure changes in the last three hours. These findings are collected from every station and plotted on a master map. Isobars are

** Note that most topographic maps are not yet metricated.

then drawn in at 4 millibar intervals, areas of high and low pressure are identified and the position of fronts plotted in. Highly simplified but nonetheless useful versions appear in most daily newspapers.

All such maps record direct observations and can be used as source material for the study of the atmosphere at a certain time (see Exercises E and F). Studied in sequence they provide a graphic, dynamic picture of the weather. Compared and contrasted over a period of months, seasons and years these maps reveal the essential characteristics of the climates they represent.

Exercise E

Using the official weather map

Refer to Figure 19.

- (1) Select one or two stations and use the station model to find out everything possible about conditions at the place at 1900 EST on September 29th. (At Ottawa at 7 p.m. the temperature was 12° C, sky almost clear with only small patches of altocumulus at the middle level, almost no wind, sea level pressure 169 and rising, dewpoint 2° C. In southwest Nova Scotia at 8 p.m. the temperature was 10° C, sky is completely overcast with light but steady rain falling, very light northeasterly winds, pressure at sea level 179 and falling, dewpoint 10° C.)
- (2) Identify and note the location of the various air masses. What are the main characteristics of the Continental Arctic air? (Cold, just above freezing in most places, overcast skies, light northerly winds, high pressure) Of Maritime Tropical Air? (Warm, mid 20's, overcast skies, light southerly winds, low pressure) What type of air covers most of Canada? (Arctic)
- (3) Identify the main high and low pressure systems. Compare pressure changes on the east and west sides of the high pressure area over Canada. Suggest possible reasons for this difference. (Pressures are rising on the east side with the approach and strengthening of the high pressure system; falling on the west side in the wake of the passage of the high and in response to the approach of the next low. All systems tend to move in a generally west to east direction in association with the prevailing westerly wind pattern in these latitudes.) Are skies generally clear or cloudy in high pressure areas? (Clear) Suggest why conditions in northern Ontario and Québec do not accord with this pattern. (In their passage over the waters of Hudson Bay the northerly winds have picked up sufficient moisture to produce overcast skies and even some light snow when they rise over the slightly higher ground immediately south.) Which systems generally produce more rain? (Lows)

- (4) Note the locations of the various fronts. Find places where there is a marked difference in the temperature on either side of a front. (Southwest of Winnipeg; near Lake Charles) Which type of front is associated with steady rain? (Warm)
- (5) How does this map help explain:
 - (a) Why the Pacific coast is notorious for its heavy winter rainfall? (There is a steady progression of low pressure systems from the Pacific bringing warm, moist air.)
 - (b) Why the Great Lakes—St. Lawrence Lowlands are noted for rapid changes and extreme variation in their weather. (They are located in the frontal zone between several different air masses.)
 - (c) How weather helps to account for the essential "northness" of Canada? (Canada is covered by Arctic and Polar air.)
- (6) Having examined the general weather picture attempt to account for existing weather conditions at your selected stations. (Ottawa is overlain by clear Arctic air on the fringe of a strong high pressure system centred over northwestern Ontario. This air extends throughout the Great Lakes-St. Lawrence Lowlands making this the only part of Canada enjoying sunny skies. Pressure is rising as the continental high strengthens. Southwestern Nova Scotia is under the influence of the low pressure system located immediately to the south. With the approach of this system pressure is falling and the mixing of warm and cold air along the fronts associated with this system have resulted in overcast skies and steady light rain.)

Exercise F

Using the newspaper forecast map

Refer to Figure 32.

- (1) Identify the major weather systems shown. (Three lows)
- (2) What is the dominant factor associated with these systems? (Rain along fronts)
- (3) Comment on the temperatures. (Mild, diurnal range about 7° C, temperatures decrease east and north of the B.C. coast)
- (4) Relate the regional forecasts to the positions of the weather systems. (A succession of low pressure systems is moving eastward across British Columbia. One is about to enter Alberta and interior British Columbia is still experiencing a few showers in the wake of this system. Precipitation there will decrease as the day goes on but skies will remain cloudy. The western half of the province is experiencing the reverse condition. The cloudy but dry conditions experienced

during the passage of a very weak ridge of slightly higher pressure between the two lows will be succeeded by increasingly heavy rainfall with the approach of the low pressure system presently centred near the weather ship.)

Climate is concerned with the average weather conditions of a place or region throughout the season. It is far less tangible than weather and can only be studied with reference to cumulative statistics whether in table, graph or map form. Climatological data is available from many textbooks and atlases and from the Canada Year Book.

Most commonly used are the mean monthly temperature and precipitation statistics. Students can quickly learn to grasp the essential information therein (see Exercise G).

Exercise G **Using Climatic Data**

Refer to the statistics in Figure 19 to find out:

- (1) For how many months are the average temperatures at Montreal (Toronto) below freezing? (4, 3)
- (2) What is the lowest average monthly temperature at Montreal (Toronto)? (-10°C -4°C)
- (3) Compare the average temperatures for the summer months at Montreal and Toronto. (Toronto is a little hotter)
- (4) What is the mean annual range of temperature at Montreal (Toronto)? (30°C 25°C)
- (5) What is the average annual precipitation at Montreal (Toronto)? (96cm 77cm)
- (6) How is the precipitation distributed throughout the year? (Evenly)

It is evident that these stations in the Great Lakes-St. Lawrence Lowlands experience cold winters and warm summers and receive moderate precipitation evenly distributed throughout the year. It is also apparent that in Montreal, some distance east and north of Toronto, winters are somewhat colder, summers a little cooler and precipitation appreciably heavier. These data can provide a generalized picture of the basic characteristics of the climate of the region, particularly as contrasted with that of other regions. But they are very incomplete and somewhat misleading. Although the average temperature in Toronto's warmest month is only 22°C the city in fact frequently and regularly experiences summer highs well up in the 30s. (And note that although the average temperature for September at Toronto is 17°C , the recorded temperatures at 7 p.m. on September 29th was only 10°C).

Although the average temperatures for the months of both October and April are higher in Toronto than in Montreal, the average date of the last spring frost is later in Toronto than in Montreal and the average date of the first fall frost is earlier. Furthermore, average temperature and precipitation figures give no hint of the ice storms, thunderstorms, high humidities and sudden hot and cold spells that are characteristic of the region. Viewed in the absence of additional material average figures give a very inadequate picture of the actual conditions of the environment.

By joining together stations with the same value of certain elements, isopleths are created which show the geographical distribution of those elements. Familiar examples of isopleths are isotherms which show temperature, isobars which show pressure (and are plotted on the daily weather maps), isohyets which show precipitation, isohels which show sunshine and isonephs which show cloudiness. The 5°C January isotherm, for example, separates those areas with average January readings above 5°C from those recording less than 5°C and the 100cm isohyet divides the area receiving more than 100cm precipitation from that which receives less than 100cm. It is thus possible to gain some visual impression of the spatial distribution of certain elements. The January isotherms for the Great Lakes-St. Lawrence Lowlands, for example, indicate that midwinter temperatures show a general decrease towards the north and east (as is borne out by the statistics in Figure 20). Similarly the relevant isopleths reveal that in Manitoba average annual precipitation decreases towards the north and west, in Nova Scotia the growing season lengthens towards the coast and in British Columbia summer temperatures increase markedly towards the interior.

By examining and correlating such material climatologists have attempted to divide Canada into climatic regions such as those depicted in Figure 6. The material is complex and no two classifications are alike. However the study of such maps does help give students some idea of the extent of areas with certain climatic characteristics.

No one source can provide an adequate picture of the climate of a region. It is necessary, therefore, that teachers and students learn to extract the relevant information from a variety of sources and then correlate it into a whole. Interpretation generally becomes more difficult as the data becomes more generalized and as larger areas and smaller scales are encountered. The daily weather map, despite its fearsome appearance with a multitude of weird and unfamiliar symbols, is in fact much closer to the students' real experience and much easier to interpret than is the deceptively simple-seeming map of annual precipitation with its plain colour wash of varying shades of blue.

Literature is often neglected in the attempt to obtain an accurate image of the Canadian environment. Writing, particularly good writing, can create a dimension of feeling and atmosphere that is often lacking in visual material. The following description of a prairie river in spring, for

example, has a dynamic quality that is unattainable from maps or pictures.

The water was very high and fast. It was also very wide, almost like a lake, and small islands with trees growing on them were in the middle of the stream . . . Although the Saskatchewan looked wide and serene, it was really very fast and treacherous. It created sandbars overnight and then as quickly washed them away again. Sometimes, it scooped out deep holes, and undermined the banks in unexpected places.

(From *Gully Farm* by Mary Heimstra, Toronto: McClelland and Stewart, 1966.)

Suitable passages can be selected for detailed study but students should be encouraged also to read complete works in order to soak up the atmosphere (and also to promote the integrated approach to Canadian Studies). Among the wealth of such material available are Ringuet's *Thirty Acres*, Sinclair Ross' *As For Me and My House*, Gabrielle Roy's *Where Nests the Waterhen* and Paul St. Pierre's *Breaking Smith's Quarter Horse* are particularly recommended.

Newspapers, magazines and advertisements also yield a wealth of material and classes should be encouraged to take advantage of the abundance of "live" resource material. How many groups have studied French Canada but failed to interview the student who has visited or lived there? How many mine the material brought home from vacation trips to other parts of the country? How many make use of parents, pen pals, billets, exchange students and so on? By taking full advantage of such sources studies become more personal and dynamic, less theoretical and more practical.

With such a wide variety of materials available the teachers' problems are often those of making choices. In making their selections teachers will be guided by many considerations such as size of class, the availability of equipment, the age, ability and aptitude of the students and the teachers' own strengths and weaknesses. Practical considerations will also play a large part in the decision-making process. Home study requires multiple copies of the materials, available in textbooks or as handouts, or adequate library facilities. Slides and movies require special equipment, perhaps prearranged scheduling in a particular room. Some students are more able than others to work independently and can better handle individual and group assignments.

A few hours invested in overall course planning will pay dividends. This will help ensure reasonable coverage of the course. Scheduling need not and should not be rigid. There may be good reasons for lingering over some units and skimming, even omitting, others. This may be decided at the outset or in response to the momentum of the class as it proceeds. However as much consideration should be given to what is left out as to what is emphasized. It is not defensible to plan a programme and simply complete as much as can be covered by closing day. However, the final units can be covered relatively quickly using skills acquired earlier in the programme. Group activities, choices of

topics and "research and report" sessions all assist in flexible timetabling. An obvious arrangement is to start with detailed local study and proceed via more general study of the home region to comparative studies of the other six major regions of Canada.

A quick inventory of available materials at the outset will likewise be of great value. The approved text, however unsuitable or inadequate, almost certainly contains some useable material whether it be a useful picture, map, graph, or statistical table. It is particularly important to identify these since they are the materials most readily available for home assignment. Having learned how to handle the material in class, students can practice their skills on their own and at the same time provide the teacher with some indication of their level of competence. Loan material must be investigated (and consideration given to ordering some items in advance). Having discovered what the options are, teachers are ready to plan individual units and lessons making use of whatever materials seem most suited to their particular situations.

Lessons are usually more cohesive if the study addresses itself towards the solution of some specific question such as "Why does the ocean play such an important role in the economy of Nova Scotia?", "What are the major environmental problems facing farmers on the Prairies?", or "How has the environment affected the development of transportation in British Columbia?" The question, "Why is the Canadian Arctic largely unpopulated?" can be addressed using only the source materials presented in *Canada: a Land of Physical Diversity*.

This type of structure requires the students to extract their own information, to make a permanent record of their findings, to enrich their experience through another medium and finally to consider the significance of their discoveries. Variations and permutations on this method can be applied to any other part of the six major regions of Canada. There is merit in learning a skill and proceeding to apply it to another situation but few things are more dreary than the application of the same formula time after time. With the wealth of materials available it is not difficult to avoid such monotony. If the study of the Barrens was rooted in the examination of a sample area by means of photographs and large scale maps, that of the Drylands might well be approached through the pages of Palliser's journal with photographs used incidentally as illustrations. The Cordillera could be learned about by an examination of the quest for suitable farmland via the study of land classification maps and meteorological data. It is fitting that the tremendous variety of conditions experienced in the Canadian environment should be reflected in the variety of approaches to study units. This applies to the planning of both the overall programme and the individual lessons.

A.B. Hodgetts in *What Culture? What Heritage?* discovered a "feeling for the land" to be the most positive identification with their country made by young Canadians. By seeking diligently for stimulating and

exciting ways of making real those parts of the country outside a Canadian student's personal experiences, teachers of the environment can help to strengthen national awareness and to safeguard this land for future generations. It is hoped that this volume will have provided some assistance in this enterprise.

SUGGESTED READINGS

Anderson, Margaret. *Splendour of Earth*. George Philip and Son Ltd., London, 1954.

A collection of descriptive prose and poetry by famous authors portraying environmental features by categories (mountains, rivers, climatic types, etc.) organized specifically for geographical purposes.

Bacon, Phillip (Ed.). *Focus on Geography: Key Concepts and Teaching Strategies*. 40th Yearbook, National Council for the Social Studies 1201 Sixteenth Street, N.W. Washington, D.C. 20036, 1970.

Focusses on new perspectives both on the geographers' traditional interests and on learning and teaching geography content.

Blair, C.L., & Simpson, R.I. *The Canadian Landscape: Map and Air Photo Interpretation*. Copp Clark, Toronto, 1978.

A fine collection of Canadian air photos and topographic maps with instructions on how to use them and exercise questions on each one.

Board, C. Fieldwork in Geography, *Frontiers in Geographical Teaching*. Richard J. Chorley and Peter Haggett, (Eds.) Methuen, London, 1965.

A discussion of the role and value of fieldwork.

Bull, G.B.G. Fieldwork in Towns, *Geography*, Vol. XLIX, Part 3, July 1964. Philip and Son Ltd., London,

Practical suggestions for fieldwork in urban areas.

Chevrier, E.D., & Aitkens, D.F.W. *Topographic Map and Air Photo Interpretation*. MacMillan Co. of Canada, Toronto, 1970.

Air photos and maps with instructions on their use and exercise sections. More than half of the selections are Canadian.

Jeverson, John. Fieldwork in Geography, *New Directions in Geography Teaching*, Rew Walford (Ed.), Longman, London, 1973.

Examines the objectives, methods and value of field studies.

Fairgrieve, James, *Geography in School*. University of London Press, 1930.

This classic of the inductive method in Geography teaching still provides valuable reading for social studies teachers.

Graves, Norman J. *Geography in Education*. Heinemann Educational Books Ltd., London, 1975.

Reassesses as the place of geography in education and considers what to teach and how to teach it.

Graves, Norman (Ed.) *New Movements in the Study and Teaching of Geography*. Temple Smith, London, 1972.

An examination of the current directions of geography and the problems presented for its teaching at the secondary level.

Hill, Wilhelmina, (Ed.). *Curriculum Guide for Geographic Education*. National Council for Geographic Education, Box 303, Faculty Exchange, Norman, Oklahoma, 1973.

Useful chapters on skills, techniques and resources.

Hillary, Vicki & Hillary, Derek, (Eds.). *The Canadian Source Book of Educational Materials*. Canadian Educational Resources for Teachers, Cert Company, Box 3430, Station B, Edmonton, Alberta.

Catalogue of free and inexpensive materials with practical information on ordering, copyrighting, unit planning and grading.

James, Linnie B., & Crape La Monte. *Geography for Today's Children*. Meredith Corporation, New York, 1968.

Explores how relationship geography is developed, how geographic concepts are introduced and when geographic tools may be used effectively.

Joyce, Bruce R. *Strategies for Elementary Social Science Education*. Science Research Associates, Inc., Chicago, 1965.

Discusses the broad spectrum of social science education of which the study of the environment is a part. Strategies, materials and methods for teaching the subject discipline by pursuing that discipline in the manner of the scholar are examined.

Moore, Evelyn, & Owen, Edward E. *Teaching the Subjects in the Social Studies: A Handbook for Teachers*. MacMillan of Canada, Toronto, 1966.

Detailed practical suggestions for the application of the major principles of geography teaching.

Stringer, W.N. Questions Used in Teaching Geography: Types, Conceptual Levels and Sequence. *Geographical Education*, Vol. 2, 1974, pp. 207-216. Australian Teachers Association.

Sully, G. Barry *Aerial Photo Interpretation*. Bellhaven House Ltd., Scarborough, Ontario, 1969.

Contains information on where to obtain aerial photos, how to make a simple stereoscope. Heavily oriented toward geomorphology and therefore of particular value in environmental studies. Much of the material is Canadian but almost none is identified.

Thralls, Zoe A. *The Teaching of Geography*. Appleton Century Crofts, Inc., New York, 1958.

Outlines the development of skills and abilities for the acquisition of geographic information.

Walford, Rex. *Games in Geography*. Education Today Series, Longman, London, 1969.

Ideas and examples on the use of games in geography teaching.

Wright, Ian. *Elementary Social Studies: A Practical Handbook to Teaching and Learning*. Methuen, Toronto, 1980.

Clear guidelines, plentiful illustrations and selected sample units assist teachers to apply concept development methodology to the teaching of social studies.

Atmospheric Environment Service

FOR

Nova Scotia
New Brunswick
Prince Edward Island
Newfoundland
Labrador

Québec
Baffin Island

Ontario
(west to Thunder Bay)

Ontario
(Thunder Bay and west)
Saskatchewan
Northwest Territories
(between about 80° and 108°
longitude)
Arctic Archipelago

Alberta
Yukon
Northwest Territories
(west of 108° longitude)

Pacific Region:

British Columbia

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